D. S. I. R.
... Reading Library
... and
... nology.
8936 A

23-4

TRANSACTIONS *of the* ILLUMINATING ENGINEERING SOCIETY

Founded in London in 1909 and incorporated in 1930

Volume 23 Number 4 — 1958

Officers of the Society, Session 1957-1958

President E. B. SAWYER (FELLOW)

Vice-Presidents F. X. ALGAR B.SC. (FELLOW) N. BOYDELL M.I.E.E. A.M.I.MECH.E.
R. G. HOPKINSON B.SC. (ENG.) PH.D. M.I.E.E. (FELLOW)
J. S. MCCULLOCH ASSOC.I.E.E. (FELLOW) C. C. SMITH M.I.E.E. (FELLOW)

Honorary Secretary J. G. HOLMES A.R.C.S. B.SC. (FELLOW)

Honorary Treasurer W. ROBINSON B.SC. A.M.I.E.E. (FELLOW)

Honorary Editor of Transactions H. HEWITT A.M.I.E.E. (FELLOW)

Secretary G. F. COLE

TRANSACTIONS *of the*
ILLUMINATING ENGINEERING SOCIETY

Volume 23 Number 4 1958

Contents

179 **Character and Compromise in Hotel Lighting**
C. Dykes Brown M.I.E.E. (FELLOW) and *W. R. Stevens* B.SC. M.I.E.E. (FELLOW)

201 **Lighting and Architecture**
G. Grenfell Baines A.R.I.B.A. DIP.T.P. A.M.T.P.I. (MEMBER)
and *A. L. Hogg* A.M.I.E.E. (MEMBER)

211 **Design and Production of Glassware for Lighting**
D. Shellshear M.S.I.A. and *C. D. Cartwright* B.SC.

224 **Additions to the List of Members**

225 **Society Publications**

TRANSACTIONS

of the

ILLUMINATING ENGINEERING SOCIETY

Volume 23 (Nos. 1-4) 1958

CONTENTS

	Page
Presidential Address : Designing for Harmony, by E. B. Sawyer... ...	1
Artificial Lighting as Applied to Museums and Art Galleries, by W. E. Rawson-Bottom and J. B. Harris	6
Television Studio Lighting Equipment, by K. R. Ackerman	28
Report of the Council	44
Papers for the Transactions	57
Recommendations to authors of papers	57
Sir John Herbert Parsons	63
Lighting of Aircraft Control Panels, by J. W. Strange and B. Stevens ...	65
Ambient Temperature Effects in the Photometry of Fluorescent Lamps, by W. R. Blevin	84
Lighting and Safety in Building Operations and Works of Engineering Construction, by J. Gordon Scott	87
Lighting Design—The Next Step	101
Design of the Visual Field as a Routine Method, by J. M. Waldram ...	113
Characteristics and Applications of Photo-Electric Cells, by F. A. Benson	127
Lighting at the Brussels 1958 Exhibition, by Andre Boereboom	148
Lighting in Finland, by E. Paivarinne	163
Mr. Guy Campbell	174
Annual General Meeting	175
Additions to the Library	176
Character and Compromise in Hotel Lighting, by W. R. Stevens and C. Dykes Brown	179
Lighting and Architecture, by G. Grenfell Baines and A. L. Hogg ...	201
The Design and Production of Glassware for Lighting, by D. Shellshear and C. D. Cartwright	211

Authors' Index

		Page
ACKERMAN, K. R.	Television Studio Lighting Equipment ...	28
BAINES, G. GRENFELL	Lighting and Architecture	201
BENSON, F. A.	Characteristics and Applications of Photo-Electric Cells	127
BLEVIN, W. R.	Ambient Temperature Effects in the Photometry of Fluorescent Lamps	84
BOEREBOOM, ANDRE	Lighting at the Brussels 1958 Exhibition...	148
BROWN, C. DYKES	Character and Compromise in Hotel Lighting	179
CARTWRIGHT, C. D.	The Design and Production of Glassware for Lighting	211
HARRIS, J. B.	Artificial Lighting as Applied to Museums and Art Galleries	6
HOGG, A. L.	Lighting and Architecture	201
PAIVARINNE, E.	Lighting in Finland	163
RAWSON-BOTTOM, W. E.	Artificial Lighting as Applied to Museums and Art Galleries	6
SCOTT, J. GORDON	Lighting and Safety in Building Operations and Works of Engineering Construction	87
SHELLSHEAR, D.	The Design and Production of Glassware for Lighting	211
STEVENS, B.	Lighting of Aircraft Control Panels ...	65
STEVENS, W. R.	Character and Compromise in Hotel Lighting	179
STRANGE, J. W.	Lighting of Aircraft Control Panels ...	65
WALDRAM, J. M.	Design of the Visual Field as a Routine Method	113

UDC 628.97

Character and Compromise in Hotel Lighting

By C. DYKES BROWN, M.I.E.E. *(Fellow)* and W. R. STEVENS, B.Sc., M.I.E.E. *(Fellow)*

Summary

The hotel industry is important not only for its size and the vast sums of money involved but also for the peculiar nature of its service, since a visitor's impression of a distrct or a country is greatly influenced by the hotels he visits. It is important that each hotel should establish a distinctive and attractive character and in this lighting takes a significant place.

However, there are many limits to the lighting installation. Costs must be kept within a budget, which is often small, and careful thought must be given to maintenance, particularly in a large hotel. The main problem of compromise arises, however, from the wide variety of users of a hotel and the fact that the decor can only receive a major overhaul at long intervals. This is a severe restriction on the designer.

The areas of a hotel used primarily by the staff are working places in which the lighting can follow well established practice. The areas used by guests present much more difficulty because the requirements are often nebulous and the possible methods of lighting are many and varied. The paper, therefore, gives some specific recommendations for staff areas, but for guest areas the broad requirements are stated, some lighting principles discussed, and typical solutions illustrated both for interiors and exteriors. An appendix suggests a simple approach to design based on the apparent brightness technique.

(1) The importance of character

There are some 6,100 licensed hotels in Great Britain whose aim is to provide " for the lodging and entertainment of travellers "(1) Unlicensed hotels and boarding houses enlarge the total to over 50,000 with at least 1,080,900 beds.(2) Youth hostels and holiday camps provide more than 110,000 beds in addition. Apart from the many people who travel in the course of their business and apart from the holiday-makers (half of the population of the country takes paid holidays) over 1,000,000 overseas visitors come to Britain annually bringing an income of £170,000,000, nearly half of which is spent in hotels.

As well as guests who sleep in hotels there are many more who eat; and some idea of the problems of organisation may be gauged from a statement made to the authors that in one first-class hotel having 100 bedrooms, 20,000 pieces of linen are laundered per week and 5,000 pieces of crockery replaced per year. The hotel industry is important, however, not only for its size and the vast sums of money involved, but for the peculiar and personal nature of its service. A stranger to a district or a visitor from abroad is probably more influenced by the hotel in which he stays than any other single factor. The hotel is the ambassador that stays at home.

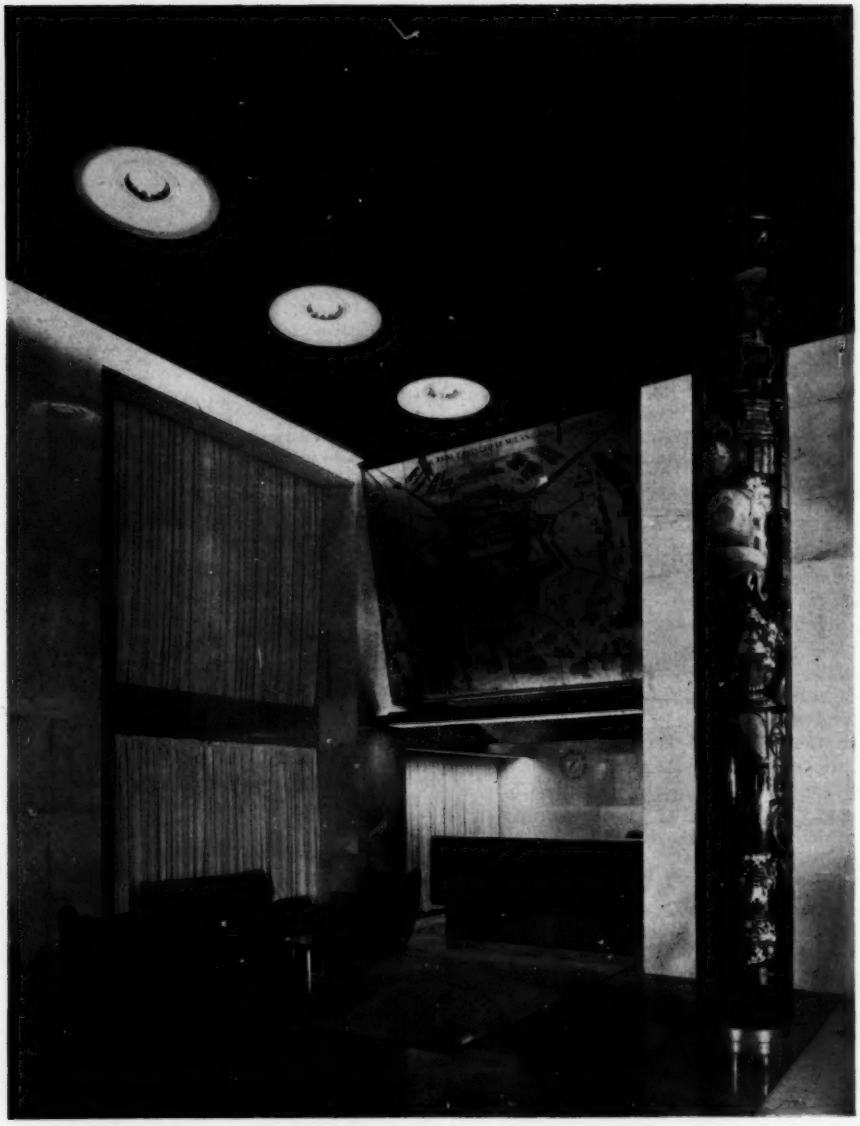
Many things combine to affect a guest's judgement of a hotel, such as the service, the food, the comfort of his bed, the convenience of his bathroom. One of the most important, and certainly the one which makes the first major impact is appearance. Immediately on entering the hall of a hotel an impression is formed which will influence all subsequent impressions. Do we find elaborate chandeliers hanging from a lofty ceiling and rich carpets on the floor ? Do we find a decor of bare lamps and chromium plate ? Is the character the so-called " contemporary " with bright colours and " free-arrangement " groupings of lights ? The visitor will probably not analyse what he sees, but he will " sum up," and often in his own mind will form there and then a lasting impression of the hotel.

Is the lift grubby and box-like, or clean and airy ? Are the corridors safe to walk along or are they so dark that changes in floor level and tears in carpets are dangerous hazards—and do they appear to be interminably long ?

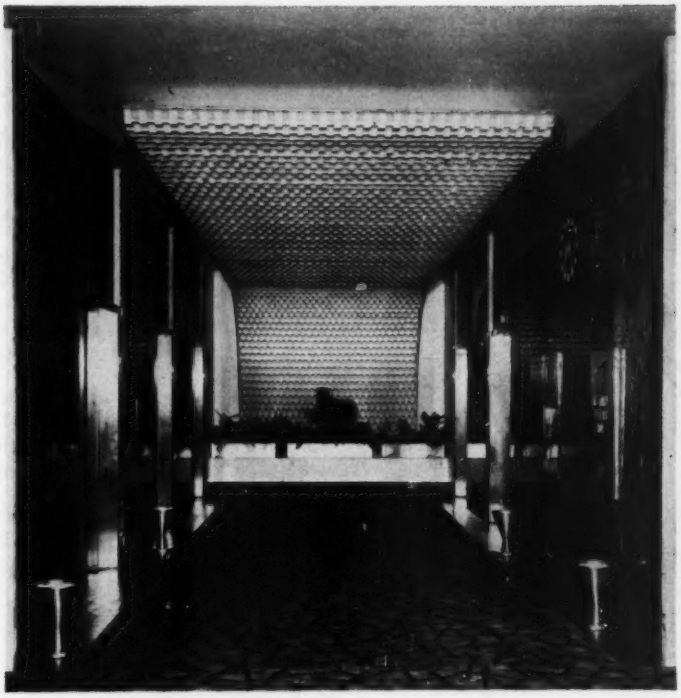
The character of the hotel is now so clearly defined that the bedroom will probably not come as a surprise. We know whether to expect a bare lamp on a piece of frayed flex or an attractive system of wall brackets. We shall not be too surprised by the performance of the bed head light and the facilities for shaving.

To a considerable extent the other services in a hotel can be anticipated from this introduction, for generally the management that prides itself on its cuisine and its service will take care to achieve a distinctive character in decoration and appointments. It is true that a few places have established a reputation for first-class food in second-class surroundings; indeed, in some restaurants the

The authors are with The General Electric Co. Ltd. The manuscript of this paper was first received on January 10, 1958, and in final form on March 13, 1958. The paper was presented at a meeting of the Society at Eastbourne on May 14, 1958.



Concealed and built-in lighting emphasises the detail and character of this entrance hall of the Grand Hotel, Duomo, Milan.



Novel elevator lobby; woven plastic strips conceal 8 ft. warm white fluorescent tubes. The motif is repeated inside the elevator. Statler Hilton Hotel, Dallas.

"near-shabby" atmosphere seems to be used to emphasise that good food and good food only is their business. But this can hardly apply in a hotel, particularly a large one. In such establishments a battered lighting fitting often goes hand in hand with a cracked wash basin, and a guest may well suspect that if the decorations are drab the food will be drab also. If, in addition, the public rooms are dirty he will have grave doubts about the housekeeping in the kitchens.

The importance of atmosphere or character has been discussed by the authors with several managers of important hotels. They are all agreed that it comes high on the list. Some place it first, most put it second to food, all insist that it has a profound effect on customer reaction. It is a feature on which both guests and staff comment to the management.

Of the many details which create character it is obvious that lighting takes an important place with decoration and furnishing. It is profitable, therefore, to spend money on lighting and to take trouble with it. This is the basis for the more detailed subsequent discussion in this paper.

(2) The need for compromise

There are, however, many limits on what may be done reasonably in a hotel, as in all other lighting installations. Initial cost is an obvious one. The lighting designer will often feel that the allowance for lighting is meagre—and he may well be right—but the heating and ventilating engineers will feel similarly, as will the suppliers of carpets, curtains, furniture, linen, kitchen equipment and the rest. The lighting must be paid for within a budget. The obvious course is to design the lighting scheme so that the budget will cover good equipment; simple and satisfactory is far better than florid but faulty.

Maintenance is a serious matter. In a hotel of about 100 bedrooms with the associated public rooms, there may well be 2,000 lamps. Almost all of them will be incandescent lamps and the average burning hours about 12 per day; thus some two dozen lamps will fail each day. This presents no mean problem. In a factory a few unlighted lamps do not present a serious problem; in a hotel a single failure may be as unattractive as a missing tooth and the manager will pounce

on his electrical staff if the lamp is not quickly replaced.

In view of the economic advantages of tubular fluorescent lighting much more attention should be paid to its use in hotels. The high efficiency and long life of both hot and cold cathode fluorescent tubes can effect useful savings in running costs, not only by the saving in energy consumed but also by reducing the frequency of lamp replacement. Many hotel managers say that they dislike fluorescent lighting because it is either uninteresting or glaring ; and the bigger and more expensive the hotel the more firmly is this attitude expressed. This is an interesting challenge to designers of lighting equipment.

The many opportunities to use cornice lighting and laylights, for which tubular sources are well suited, are only taken to a limited extent. Cold cathode tubing has advantages in such installations since the life may well exceed 25,000 hours and mixtures of tubes are available which give colours particularly flattering to the complexion.

Lighting equipment must be cleaned : preferably it should be easy to clean, which some of the more popular patterns are not. A striking example is the crystal chandelier found in many luxury hotels. When new and sparkling the chandelier has an obvious appeal but when dirty and dingy it is most unattractive. On a tour of inspection of hotels, both in Great Britain and on the Continent, the authors saw few crystal chandeliers that were really clean, and this is not surprising when one learns that it takes one man three days to clean a relatively small chandelier.

The correct choice of equipment, and perhaps some attention to the design of suitable raising and lowering gear for the high mounted fittings, could save a great deal of money during the life of the installation.

The main problem of compromise arises, however, because the users of a hotel vary so widely. The atmosphere appropriate to a business discussion is not that of an engagement party ; the commercial traveller will have different needs from a theatrical artiste on tour.

Hotels cater for so many different sorts of people with so many different tastes that what pleases the one may well offend another. The designer is faced with trying to attract the maximum variety of tastes. If he is bold he may well make an enormous appeal to a few but be disliked by the many. If he produces a " safe " scheme it may be so ordinary as to have no character worth considering. Thus there has grown up a hotel decor which is so well established as to occasion no adverse comment because it attracts no special notice ; it is acceptable, no more and no less.

When a new building is being erected or an old one is having a major reconstruction, the designer must decide between safety and boldness. He cannot design in a style which happens to be fashionable unless he can expect that fashion to last for many years, for a hotel can only receive a major overhaul at intervals of a quarter of a century or more. Thus the lighting system must not be quickly outmoded. In general, one would expect systems of built-in lighting, integral with the construction of the interior to have the

Dining room lit by red and white cold cathode fluorescent tubing in cornice ; highlights provided by tungsten wall brackets. Gold motif in ceiling. Very pleasant quality of light both for food and complexion. Kempinski Hotel, Berlin.

required permanence of style ; the designer should always consider using this technique as part of his lighting scheme.

(3) Requirements and recommendations

It is convenient to divide the hotel into two parts, the Guest Areas and the Staff Areas. The Staff Areas are mostly working places such as kitchens where efficient use is the aim and decorative effects are relatively unimportant. It is possible to make fairly definite recommendations for these workrooms since in all of them the " seeing task " is known and the lighting methods can follow well established practice.

The Guest Areas, however, present much more difficulty, sometimes because the visual requirements are not easy to define—as in a lounge—sometimes because the prime need is for a decorative result at reasonably low cost. In these areas the need for compromise is most important and it is not possible to lay down hard and fast rules of procedure. The designer's concept of character is the starting-point ; the finishing post is reached by close co-operation between designer and those responsible for engineering and maintaining the installation.

In the following sections, therefore, the Guest Areas are analysed in general terms ; the broad requirements are stated, some lighting principles discussed and typical solutions given. For the Staff Areas, the recommendations are more specific. A summary of recommendations is given in Table I.

(3.1) Guest areas

(3.1.1.) *Entrance halls*

The purpose of the entrance hall is to make the guest " at home " in the hotel. To do this it serves both as a reception and distribution centre ; reception in that the guest is welcomed, his rooms allocated, his special needs ascertained ; and distribution since from here are the routes to all other parts of the establishment. The initial impression created by the entrance hall should not only welcome the guest but should characterise the whole hotel. This does not mean that the same period of design must be used in the entrance hall and everywhere else in the building. It may be desired to create an " olde-worlde, half-timbered " character in the public rooms ; it does not follow that the bedrooms need to be " Tudor style " in their lighting any more than in the plumbing. But whatever style is chosen the quality and elaboration of the lighting system should reflect the status of the hotel. For this reason we often find elaborate and evidently

Novel design of lighting fittings for sun lounge. Compare design of fabric shades with window pelmet. Atlantic Hotel, Hamburg.

costly crystal chandeliers when we pass through the revolving doors of the " Grand Hotel", particularly on the Continent and particularly in hotels built half a century ago. Unfortunately when the chandeliers are dusty and the furnishings faded we get an unhappy impression of wearied magnificence.

The chandelier is not only a relic of past glories, however ; in Italy particularly it is found in many large hotels built since the war, doubtless because of the long tradition of Muranese, Venetian and other fine Italian glasses. Some interesting attempts have been made to combine such glass with tubular fluorescent lighting. The results are not always happy since it is difficult to achieve the customary sparkle with a low luminance source. There is also a frequent use of the " colder " colours, presumably to give relief from a hot climate ; the result is sometimes chilly and

depressing. It is not easy to design attractively for such " colder " colours.

The contrast between outdoor and indoor conditions is so marked and so variable that more attention should be given to varying the character of the interior according to the time, the weather and the season. A traveller may arrive after a long and tiring journey by road, rail or air, by day or by night (in many hotels the bulk of winter travellers check-in after dark); he may be hot and exhausted or soaked and shivering. In the luxury hotel, at least, one might justify having switching arrangements which would make the entrance warm and inviting or cool and refreshing as the occasion demanded. The effects could probably be achieved by completely automatic control; but a hand-switched system would be a much cheaper alternative. Such arrangements would also permit special effects to be produced for special occasions. We make too little use of the flexibility of electric lighting. In spite of the fact that a main attraction of daylight is its continuous change, we are content to have our artificial lighting static instead of exercising the control which is so easily available.

The general character of the lighting in the entrance hall will be determined by the character of the architecture and design of the space as a whole. There are some features in entrance halls which have a special part to play. One of these is the reception desk. Curiously, although this is the first port of call for the new arrival, it is often the least obvious. Sometimes there is a porter on duty to take baggage and give directions—but not always. The reception desk or the route to it should be evident immediately on entering the building. Illuminated signs are obviously helpful —and let the lettering be well chosen. The lighting system might be designed in a pattern which leads the eye correctly. The desk itself should be rather brighter than its surroundings so that attention is drawn to it. An illumination of two to three times that in the general area should be suitable.

Many other features deserve some highlighting, partly to draw attention to them and partly to give a pattern of highlights which will make the room interesting; such features include the porter's desk, cashier's desk, and entertainment guide. The entrance area and that around lift doors, as well as all places where floor levels change, e.g. steps and stairs, may need extra illumination if the main circulating area is dimly lighted. In a large entrance hall there will also be showcases, generally displaying local goods, and possibly a bookstall, florist's, tobacco kiosk and general shop. These again provide opportunities for contrasting light and shade and colour. They should not be treated separately and allowed to compete with each other, but should be part of an integrated scheme.

Where there are no showcases and the like to provide brightness contrasts the effect must be produced in other ways, for example, with ceiling and wall-mounted decorative lighting fittings, and illuminated features such as alcoves and fish tanks, bowls of flowers and pictures. One illuminated feature which often appears, but would be better concealed, is the telephone switchboard. Perhaps it is necessary for some switchboards to be inherently unattractive, with their black panels and mahogany trimmings, but it is surely possible to make the lighting a little more decorative than it often is. Frequently the authors have seen, here and abroad, a utilitarian blob lighted with a bare fluorescent tube in an otherwise attractive hall. A little imagination in the treatment pays handsomely; in one instance only a pierced screen for the lamp was needed to improve the appearance noticeably.

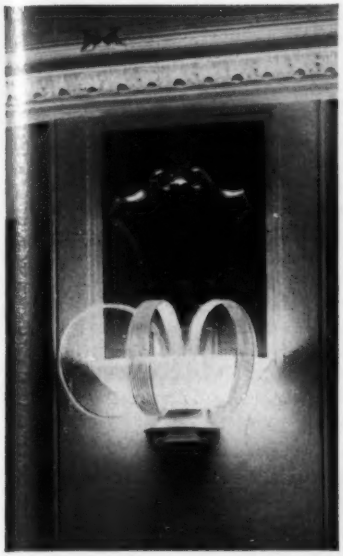
It is impossible to generalise on the correct illumination level for an entrance hall; provided the lighting establishes character, the absolute level is not of great importance. In most hotels an illumination of 5 to 10 lm/ft² is reasonable with auxiliary highlighting as already discussed, and perhaps some additional local lighting near chairs and sofas. The level of general illumination required is not related directly to the class of hotel but to the nature of the entrance hall.

(3.1.2.) *Lounges*

One difficulty in lighting a lounge is that there is no natural focal point of regard. The result is often a general lighting system of no particular character or interest. The next stage—and it is often a substantial improvement—is to produce special fittings which have an attractive appearance. A distinction should be made, however, between attractive fittings and attractive lighting; the two do not necessarily go together.

The lighting should not be uniform but should have areas of light and shade and even of different colours; the combination of general plus local lighting is sensible. In the luxury hotel, particularly in the residents' lounge, the aim is comfort and restfulness. This suggests a low level of general lighting—perhaps 5 lm/ft²—augmented by standard lamps or wall brackets to give enough light for reading at some of the seats.

In public lounges, particularly in hotels that cater for a large number of " in and out " cus-



Above, wall bracket for lounge. Reeded glass gives clever impression of water cascading from bowl. Backed by cut glass peach mirror. Waldorf Hotel, London.
Right, lounge to Grill Room, Cumberland Hotel, London. Fittings of obscured glass with incandescent lamp. Compare style of bronze finish metalwork with the motif above the doors.

tomers, it may be better to have a brighter and more sparkling decor—a sort of "chromium plate" setting. A high overall illumination—10 lm/ft² or more—will allow many groups to gather in different parts of the lounge, comparing notes (visually and verbally), enjoying a drink or making up a party for an evening's entertainment.

In either type of lounge, if it is large, the general lighting could, more often than is the practice, be provided by tubular fluorescent lighting instead of the more conventional pendants with incandescent lamps. For the quieter rooms the tubes would be in cornices; for the gayer places screening by patterned glasses might be appropriate. The colour of light should be flattering to the complexion so the "warmer" types of tube and lamp (including "pink" incandescent lamps) are suitable, generally with pink shades. Cold cathode tubes can, of course, be obtained in suitable combinations of colours.

In a small lounge—up to about 500 sq. ft. floor area—it may be possible to eliminate ceiling mounted equipment and depend on wall lights and portable lamps, because in a small room the seats are likely for the most part to be arranged close to the walls; the geometry of the room will be the determining factor. Portable lamps, such as floor standards, are vulnerable to damage and should not generally be far from a wall. Where light is required from the centre of the room, therefore, it is best provided by pendants or ceiling mounted equipment. Downlighting from flush mounted or recessed fittings is attractive and inconspicuous.

The entrance hall-cum-lounge presents a special problem if it is desired to achieve an air of brisk efficiency in the one part with restfulness in the other. Ideally there should be some indication of separation of the two parts by layout and perhaps an implied barrier such as glazing or an open screen. Light can also help. If the two functions are mixed, the compromise must depend as usual upon the analysis of usage. In a small hotel serving mostly long-term residents, the importance of the reception desk, for example, will be small and the quiet lounge atmosphere may be more

important. In other places, however, the reverse will be true, and indeed the comings and goings of guests may be a main attraction to those who are lounging.

(3.1.3.) *Dining rooms*

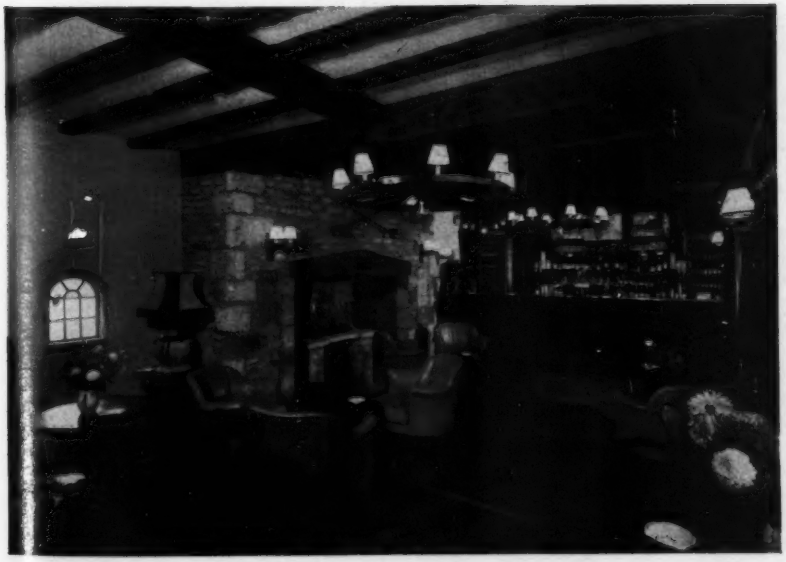
A dining room may be ebullient or discreet, communal or cosy; it may be "period" or "contemporary"; it may enhance the prospect of the meal to come or it may encourage gloomy forebodings. In general, the more luxurious and costly the food the more subdued and intimate will be the lighting, for this concentrates attention on the table, encourages sitting longer over the meal and gives more time for the associated drinks. The restaurant which is also used as a banqueting room must, however, have good general lighting.

In the "intimate" type of lighting, the aim is to make each table seem independent of its neighbours, but not isolated, so that each group of diners has the safety of a community but the satisfaction of its own company. The table is the centre of attraction and should be the most brightly lighted object; this emphasises good table linen. Glass and cutlery is most attractive when it shows bright reflections; the illuminant for the table area should, therefore, be of a source of fairly high brightness, such as a tungsten lamp, with little diffusion. The surroundings to the table should fall away into shadow; but some light should reach the faces of the diners and this should be soft (well-diffused) and warm in colour to flatter the complexion. It may be sufficient to rely on the light inter-reflected within the room for this general light, in which case the decorations should be chosen to produce a pink effect.

Luxury dining room. Individual "candles" with wall bracket; white and gold louvred shutters with concealed lighting. Empire Room, The Waldorf Astoria, New York.

The Roof Bar, Marmara Hotel, Istanbul. Imaginative ceiling treatment. Incandescent lamps behind cut-outs in blue ceiling provide a motif which accords with the lights of the city down below.

Bar and Lounge, Wild Duck Inn, Ewen, Nr. Cirencester. Ingenious treatment of typical English "pub."



This technique requires that each table should have individual lighting, although the light need not be on the table. A pink shaded table lamp can be used, or a pendant; ceiling mounted downlights are also effective. Candles are still one of the most effective ways of achieving the effect and in addition have the attraction of slight motion. One Continental hotel uses specially made candelabra in which a candle lamp gives upward light and a concealed lamp lights the table.

The general lighting decor calls for pendant fittings or downlights, perhaps in conjunction with cornice lighting. If appropriate switching and dimming facilities are provided, the room can be made suitable for different occasions ranging from the service of ordinary meals, to banquets and dancing. The aim should be a combination of direct downward light and generally diffused light so that there is some sparkle associated with the tables, but not too strong modelling and shadows. General lighting units may produce a nearly uniform brightness on walls and ceiling; this will seem dull unless offset by a strongly coloured decoration or auxiliary lights. Such dullness is often found in dining rooms where the decorations are "safe"—generally a cream colour which in time degenerates into an "old nicotine" tint. It is often more interesting to permit only a little upward light so that ceiling and walls are rather dark and somewhat non-uniform in appearance; or to illuminate indirectly a clearly defined and perhaps irregular ceiling area, so that it makes an obviously intended feature.

(3.1.4) *Bars*

In the cocktail and other bars the designer can have his fling; the only crime is if the result is nondescript. Better the bar should be disliked by some than noticed by nobody. The range of treatments to be seen is astonishing; some are almost black, as if the management were determined that customers should rely only on taste and smell, others are of overpowering brightness; some try to capture a garden atmosphere, whilst some are apparently under water. In no other part of the hotel is the attempt to establish character so obvious.

In some bars service is confined entirely to the bar with no provision for sitting; in others the bar is only a dispensing counter and all the customers sit at tables; yet others serve snacks which are often substantial meals requiring the paraphernalia of eating. In the first class of bar there is no table to light; in the second the tables require only enough light to show where they are; in the third it must be at least possible to see what one is cutting up.

The focal point is the bar itself where it seems generally agreed that there should be a good display of well-lighted bottles. Light is also required for mixing drinks and this may be provided by downlights just behind the bar or by under-bar lighting. In one Continental hotel fluorescent tubes just behind and below bar level are practically the only source of light for the whole room. The bartenders are thus brightly and dramatically illuminated with shadows running up their faces and the customers are in near-darkness, which has some merits; the overall effect is surprisingly attractive.

Downlights are sometimes the only illumination for the customer area of a bar. This is not always wise, for downlights tend to cast hard shadows which emphasise lines on the face. This form of lighting needs additional general light, well-diffused, particularly in a place frequented by ladies.

Bars are often windowless rooms and imitation windows with scenic backings are sometimes included. As attempts to deceive these are seldom successful, and it is generally wiser to let the device be an obviously artificial decorative effect. However, quite reasonable simulations of windows can be obtained by back-lighting voile curtains covering diffusing glass or venetian blinds.

(3.1.5) *Lifts*

Passengers in lifts have only the lift walls and one another to look at. Since this inspection is at very close range, the lighting should flatter; it should be well diffused and kind in colour. In one Continental hotel ladies emerge from the beauty salon looking radiant. They pass through a small pink decorated ante-room and are ushered into a lift with cold-coloured fluorescent lighting which completely ruins the effect.

Although it would seem a simple matter to light a lift, the results in practice are seldom attractive, and sometimes very poor. A frequent fault is specular reflections from shiny ceilings and walls, and from the glazing on notices and menus, making them hard to read. An illumination of 3 to 5 lm/ft^2 is suitable on the side walls of the lift; indirect lighting is probably the most satisfactory method.

(3.1.6) *Corridors*

Hotel corridors seem to go on for ever; it is worth while attempting to make them attractive, for nothing is more depressing than a gloomy corridor. There are many simple ceiling fittings

Modern treatment of bar. Prince Hamlet Hotel, Elsinore, Denmark

available which can be used. Such fittings should be of low brightness to reduce dazzle and should distribute a large proportion of their light to the walls and ceiling. There are often architectural features such as cornices, from which indirect lighting may be achieved, and wall mounted lights are also attractive. An effective method used in a Continental hotel in a very long corridor is to line it with shallow showcases individually lit. This idea is not novel, but could perhaps be used much more, the lamps lighting not only the contents, but indirectly lighting up and across the corridor. Presumably the cases would also have a rental value.

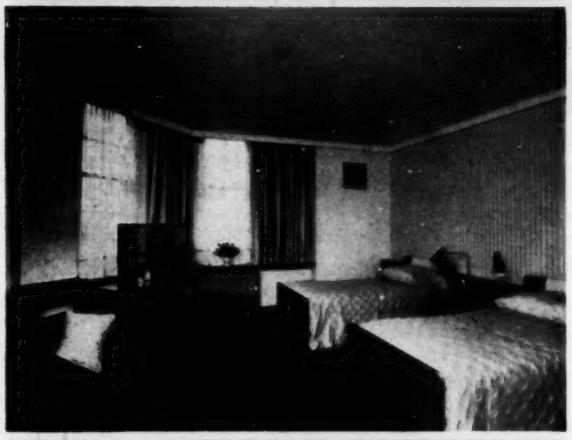
Bedroom corridors need not be too bright but it should be possible to move without falling over shoes left out for cleaning. Door numbers should be in a contrasting colour or reflection factor to the door, so that they are easy to read. The decorative treatment need not be uniform along the length of the corridor; variation, section by section, would not only add interest but would aid the visitor in locating his room. An illumination between 1 and 2 lm/ft^2 is suitable.

(3.1.7) *Bedrooms*

The first switch to be used in entering the bedroom should produce a good impression of the room. If the main lighting is a pendant it should be clean and attractive (even though cheap and simple). Better still—because less usual—is a well-chosen floor standard or a pair of wall brackets. Many new and rebuilt hotels have eliminated central pendant fittings. For example, one Paris luxury hotel has decorated all its modernised suites in off-white with pastel-shaded standard lamps. Unfortunately, not all guests are considerate, even in luxury hotels, and some managements shun portable lamps because they get damaged. This is unfortunate, because portability permits one light to serve many purposes in the hotel bedroom as in the home. An interesting alternative in one of England's few new hotels is a large wall mounted light which can be swivelled round over a large area.

An hotel bedroom is one's home for the time being. Although the prime use is for sleeping, the guest may wish to read, write, telephone, wash, shave, make-up, and these should all be possible without too expensive or elaborate a lighting system.

The general lighting may serve several of these purposes adequately; but if it is a single central pendant without supplement, the room will look dull and the many purposes for which it is required will not be properly served. Two pendants or ceiling mounted lights are very much better, not only from the point of view of appearance, but also because of the possibility of arranging them so that light reaches the wardrobe and that reading and other tasks are possible. In addition, there should be special lighting for reading in bed, for the dressing table and at the



Top left, bedroom of Dorchester Hotel, London; recently remodelled. The character of the room is greatly enhanced by the elegant chandelier and wall brackets.

Above, bedroom in Sailors Hotel, Copenhagen. Note swinging light to serve either the desk or the bedhead. The charge for this room is 6/- per night. More attention has been paid to the lighting of this hotel than is found in many luxury establishments.

Centre left, simple but handsome bedroom. Each bed has an individual adjustable light and there are two ceiling mounted fittings (not shown). Grosvenor House Hotel, London.

Bottom left, bathroom in new wing of Grosvenor House Hotel, London. Concealed lighting around one mirror. The white terrazzo shelf under the other gives upward reflected light on face from central ceiling fitting. Floor tiles in blue mosaic and wall tiles in yellow.

wash basin mirror. The bed light should be such that in a double room one occupant can read without the other being disturbed. The dressing table and mirror lights should not cast heavy shadows of the features on the face ; a white shelf under the mirror helps to relieve such shadows.

An illumination of 5 lm/ft² is satisfactory for general lighting in the bedroom but 10 lm/ft² in local areas for reading, and also at the dressing table and wash basin is desirable.

(3.2) Staff areas

Most of these working areas have their counterparts in other industrial and commercial premises so that there is a considerable body of experience available as a guide to lighting them. Generally, it is desirable to provide uniform illumination from a large number of sources so that shadows are soft and work can proceed comfortably in any part of an area. Vertical as well as horizontal surfaces are important but the use of general diffusing fittings will satisfy this requirement. The upward component should be not less than 10 per cent. of the total light output of the fitting.

Special arrangements are required in some places ; for example in the telephone exchange the switchboard is vertical and must be treated accordingly, and in kitchens supplementary lights will be needed under ventilator hoods over cookers. However, there are few such problems and they are usually easy to solve.

Equipment should be easy to clean. Totally enclosed units are attractive provided that dirt cannot enter freely and that glassware can be removed simply and quickly. A poorly constructed enclosed unit is much inferior to a good open unit, particularly if this is a " through-ventilation " type.

When fluorescent lighting is used in Staff Areas the more efficient colours such as " Warm White " and " Natural " are usually satisfactory. There is some argument for suggesting that the light in the kitchen should match, in colour, that in the dining room, but the authors have not been informed of any difficulty where chefs prepare food under fluorescent lighting.

(4) Exterior

Many hotels would be more attractive if the exterior were lighted. In country hotels set back from the road the forecourt and buildings could be lit with small expense. If there is a drive from the main road to the building it should be lighted with decorative lanterns, for example, the post-top type. They should be spaced at about 120 ft. and 13 to 16 ft. high. Loadings of 80 watts with tubular fluorescent lamps or colour modified high pressure mercury, or 150 watts with tungsten filament lamps will be adequate. An illumination of about 0.5 lm/ft² should be provided on car parks.

The grounds may be floodlighted or, more cheaply, a few trees and flower beds may be emphasised. An illumination of 1 lm/ft² will generally be satisfactory for gardens, lower values being permissible when large areas are lighted. An illuminated fountain is always an added attraction.

Floodlighting for the building will require between 1 and 10 lm/ft² depending on the surrounding illumination ; the higher value will be needed only in a city centre. For most situations 0.5 to 1 watt per square foot of lighted building face will be satisfactory with incandescent lamps. Colour may be obtained either with discharge lamps or by using filters with incandescent sources. It is most important to choose and arrange the floodlights so that a pattern of shadows is created which will give the building a solid appearance ; flat lighting is dull. There is much more to floodlighting than the haphazard disposal of a miscellaneous collection of lighting units, just as there is much more to the lighting of an hotel than installing a few pretty fittings.

Acknowledgments

The authors wish to acknowledge the generous help given by the British Travel and Holiday Association and by many hotel managements, particularly those of the following : Dorchester Hotel, Grosvenor House Hotel, London ; Leofric Hotel, Coventry ; Royal Hotel, Caernarvon ; Motels (New Forest) Ltd., Hants ; Wild Duck Inn, Ewen, Nr. Cirencester ; Hotel George V, Hotel Ritz, Prince of Wales Hotel, Paris ; Palace Hotel, Principe & Savoia Hotel, Plaza Hotel, Grand Hotel Duomo, Milan ; Excelsior Hotel, Le Grand Hotel, Hotel Quirinale, Rome ; Bundesbahn Hotel, Hotel Mark, Munich ; Hotel Kempinski, Berlin ; Hotel Kongshof, Bonn ; Hotel Four Seasons, Atlantic Hotel, Hotel Metropole, Hamburg ; Kystens Perle, Snekkersten ; Hotel Prins Hamlet, Elsinore ; Sailors Hotel, Handelstands Club, Copenhagen ; Grand Hotel, Eastbourne. Thanks are also expressed to Roberto Aloi for his assistance.

References

(1) O.E.D. Definition of Inn : An hotel is an inn " of a superior kind " There appears to be no legal definition of an hotel.

(2) Information supplied by British Travel and

Holidays Association, Queen's House, 64-65 St. James's Street, S.W.1.

There are many books and papers dealing with hotel design and construction; a comprehensive list is available through the library of the Royal Institute of British Architects.

Several periodicals have articles of interest to the lighting designer, for example: *Caterer and Hotel Keeper, Caterers Association Bulletin, Catering Management, Hotel Management, Hotel Review.*

There is also a useful review dealing with hotels in *Design* No. 109, January 1958 (Journal of Council of Industrial Design).

Appendix

Design by Appearance

In most "guest areas" the requirements are determined primarily by appearance. Ideally, therefore, a system of lighting design should be used which enables a desired appearance to be achieved. Commonly, attention is paid to choosing lighting equipment of pleasing design, but the distribution of light, shade and colour in the interior tends to "take care of itself." The approach to design suggested by Waldram[1] is intended to rectify this state of affairs and might be of particular value in planning hotel lighting. With this method the desired appearance is first recorded in units of apparent brightness—that is, brightness as seen by the eye. These units are then converted into photometric brightness—that is, the units as used by the engineer—and from these the detailed planning of the installation is possible.

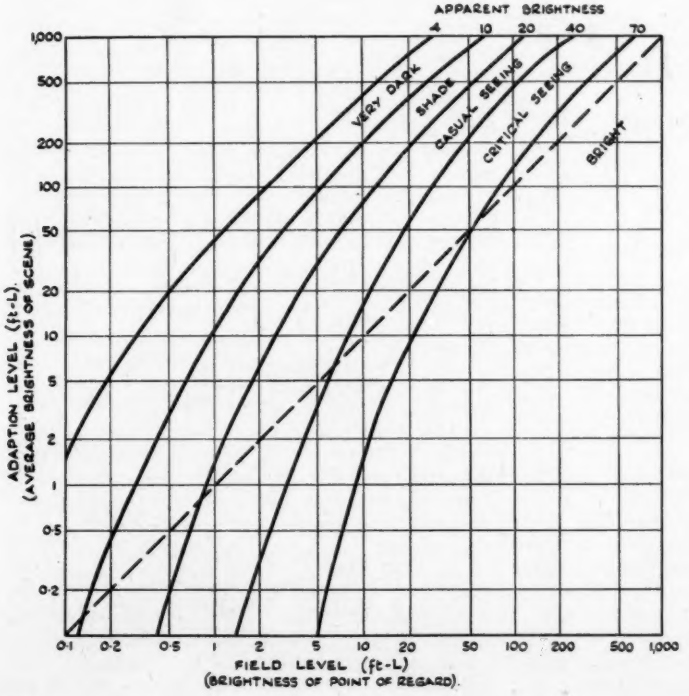
For a full description of the method the original paper should be consulted but a simple modification is useful for determining the general levels of brightness and hence illumination required to produce a desired appearance. This simplified method is based on the diagram below.

In this diagram three essential factors are related, namely:

(*a*) The average brightness level of a scene (adaptation level);

(*b*) The brightness of a particular point of regard (field luminance);

(1) Studies in Interior Lighting. J. M. Waldram. Trans Illum. Eng. Soc. (London), **19**, No. 4, April, 1954.



( ) The resulting appearance of brightness (apparent brightness).

The curved lines labelled 4, 10, 20, 40, 70 are lines of equal apparent brightness. All points on any one line appear to have the same brightness; for example, on line 10 the same appearance of brightness will be given by an object having a brightness (field luminance) of 0.3 ft-lamberts at an adaptation level of 1.0 ft-lamberts as is given by an object at 5 ft-lamberts in an average brightness of 100 ft-lamberts or another of 60 ft-lamberts in a field of 1000 ft-lamberts.

Further, the apparent brightness of the object of regard is indicated by the line on which it falls; thus any point on line 20 appears twice as bright as a point on line 10, and half as bright as a point on line 40. The curve shapes and the values ascribed to them reflect the reaction of the eye when adapted to different conditions.

By experience it is possible to ascribe common visual conditions to different values of apparent brightness. For example, if the apparent brightness is below 20 the object will appear rather dark —as if in shadow. Apparent brightnesses between 20 and 40 are those commonly accepted for casual seeing, the higher value being needed for reading; above 40 the brightness is sufficiently high for more difficult work such as sewing, drawing and reading for long periods.

The use of the diagram can best be explained by examples. Suppose it is required to design a hotel lounge suitable for general sitting and reading and without any marked variations in brightness; the overall appearance is to be bright and cheerful.

To provide a bright atmosphere with comfortable illumination for seeing an apparent brightness of 40 would be suitable. Follow the " 40 " curve and find its point of intersection with the broken line at 45 deg. This line joins all points where the object brightness (field luminance) equals the general adaptation level. At the point of intersection, the indicated brightness is 7 ft-lamberts. If the whole scene, that is both object of regard and surrounds, is at this brightness, the apparent brightness will be 40 and suitable for reading and general use. Assuming the reflection factor of the surrounds is about 70 per cent. we find that a general illumination of some 10 lm/ft² will be appropriate.

Suppose, however, it is required to have a rather quieter room in which the general level is low but with brighter areas for reading: we can estimate as follows:

Assume a suitable apparent brightness is 20. The intersection point is slightly below 1.0 ft-lambert and this determines the general level. For reading we need an apparent brightness of 40 (minimum). At a general (adaptation) level of 1.0 it is necessary to have an object brightness of 3.0 to reach an adaptation level of 40 (determined by moving horizontally along the adaptation level equal to 1 ft-lambert). Thus with a general level of 1.0 ft-lamberts the reading areas must reach 3.0 ft-lamberts. These values are now to be converted to illumination values according to the reflection factors of the surrounds. If these are medium dark—say 40 per cent., the general illumination will need to be

$$\frac{1 \times 100}{40} = 2.5 \text{ lm/ft}^2.$$

The reflection factor of white paper may be taken as 70 per cent. and the illumination under standard lamps and the like must then be

$$\frac{3 \times 100}{70} = 4.3 \text{ lm/ft}^2$$

In fact, if there are several such bright areas they and the lighting fittings will tend to raise the adaptation level so it will be well to be generous in allowing for local illumination; instead of 4.3 lm/ft² we might plan for 6 to 7 lm/ft² which is still easy to achieve with standard lamps and the like.

The essential steps in using the chart, therefore, are:

(i) Determine appropriate level of apparent brightness to achieve the desired appearance.

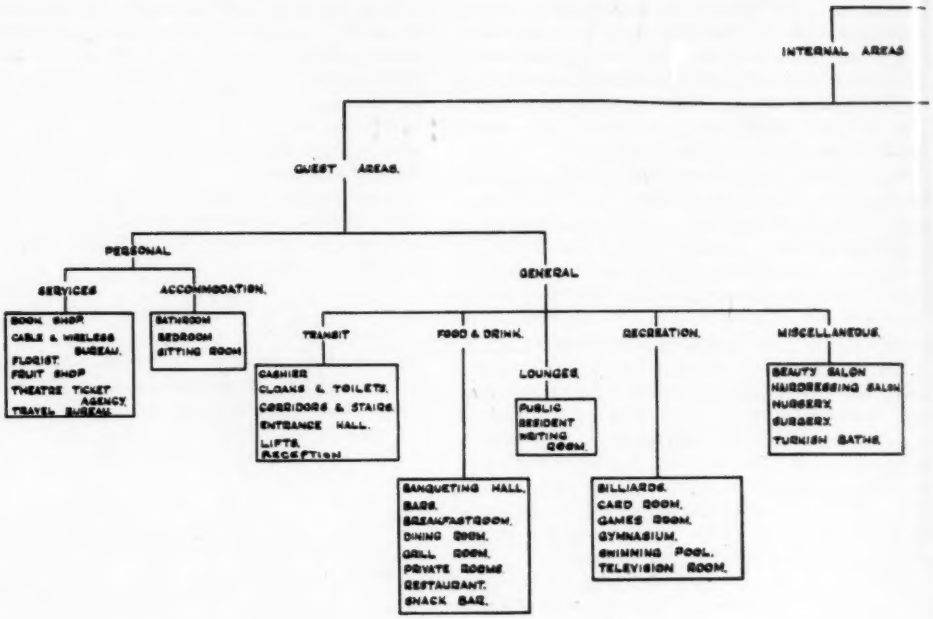
(ii) Find, from point of intersection, the basic adaptation level.

(iii) From this decide the necessary range of object brightness.

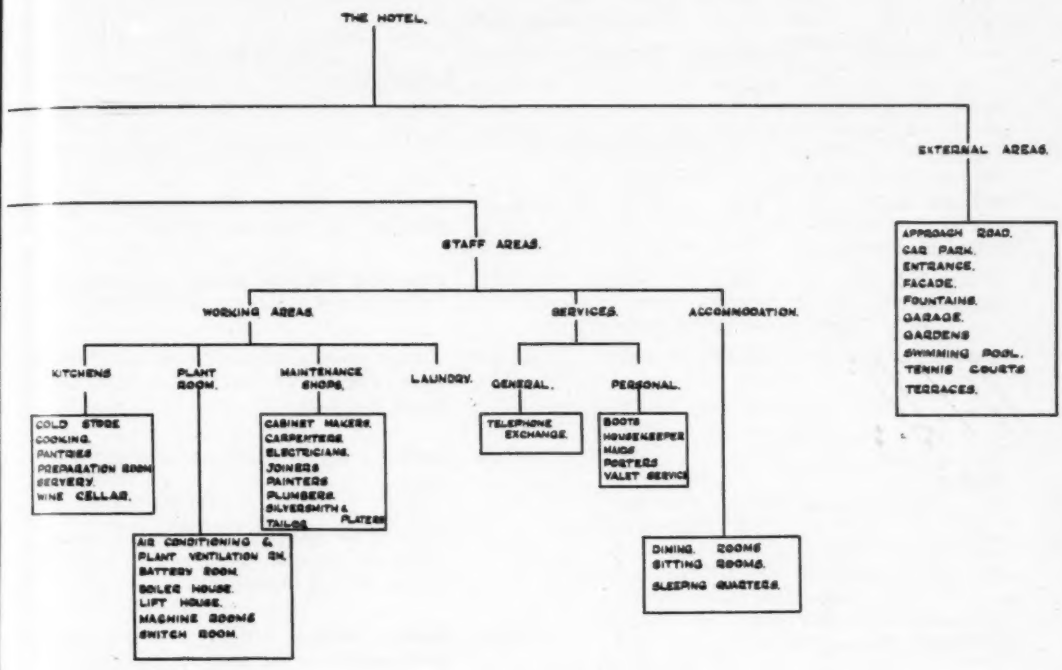
(iv) Convert to illumination, knowing the reflection factors of the decoration.

For most guest areas in a hotel the important range of apparent brightness lies between 20 and 40. When the eyes are to be used critically, as for reading, and in a writing room a value of 40 or above should be chosen. For casual purposes such as drinking and chatting, values nearer 20 would be suitable. Use of values below 20 and above 40 in one installation gives dramatic effects of light and shade.

Summary of Lighting Requirements



Location	Illumination lm/ft²	Approx. watts per sq. ft. Tungsten	Fluorescent	General Remarks
Guest Areas				
Bedrooms				
General	5	1	—	Decorative fittings to suit decor.
Bed-head				60-watt fitting with local switch.
Wash-basin	10			60-watt fitting positioned to illuminate person standing at basin.
Bathroom	5	1	—	Porcelain fitting with gasketed diffusing glass, 100-watt minimum. Additional supplementary lighting may be required for shaving mirror.
Sitting-room	5	1	—	100–200-watt decorative fitting with additional table lamps, wall brackets or floor standards as required.



Breakfast, Dining and Grill Rooms, Restaurants, Banqueting	7	1–2	0.5–1 De Luxe W/W	Decorative lighting, i.e. multilamp fittings, chandeliers, cornices, glazed features, wall bracket, table lamps, etc. Tungsten usuelly preferred but fluorescent ideal for cornices, etc. De Luxe warm white colour recommended.
Snack Bar	20	3–4	2–3 De Luxe W/W	Accent lighting by means of tungsten spots on counters. Decorative fittings. A mixture of tungsten and fluorescent De Luxe warm white preferred.
Lounge	5–10	1–2	0.5	Decorative lighting with table lamps and floor standards, illuminated features. Cornices with suitable fluorescent tubes.
Bars (vicinity of)	1–20	0.2–4	0.1–2	Usually built-in decorative features. Ensure bar-tender's area well lit. Lighting for remaining area may be subdued, depending on decorative treatment.

Location	Illumination lm/ft²	Approx. watts per sq. ft. Tungsten	Fluorescent	General Remarks
Entrance Hall	5–10	1–2	0.5–1	Decorative fittings with matching wall brackets. One large feature usual.
Cashier and Reception	20	4–5	2–3	Decorative diffusing fittings positioned to suit desks and counter.
Corridors	1–2	0.5	0.1–0.3	General diffusing fittings. Distance between fittings should not exceed 1½ times the height above floor level.
Stairways and Landings	1–2	0.5	0.1–0.3	Fittings must be positioned to reveal stair treads.
Lifts	3–5			Each lift car should have a general diffusing fitting of 60-watt minimum or built-in cornice lighting (fluorescent).
Cloakroom and Toilets	7	1–2	0.5–1	General diffusing fittings preferably with porcelain gallery and gasketed glassware.
Billiards Room				General diffusing fittings.
General	3	0.5–1	0.5–1	Mainly direct fittings suspended approx. 3 ft.
Tables				above table. If fluorescent, 2-twin 4 ft. troughs mounted 7 ft. apart.
Games Room	15	3–4	1–2	General diffusing fittings. Good lighting over table tennis tables, dartboard, etc.
Indoor Swimming Pool	7	1–2	0.5–1	General lighting with non-corrosive fittings. Additional under-water lighting will contribute to both decorative effect and safety value.
Gymnasium	10	2–3	1–2	Robust fittings ceiling mounted or recessed. Lamps should be screened from direct view.
Television Viewing Room	2	0.5	—	No direct light should fall on screen. General background against which screen is viewed must be illuminated. A 100-watt table lamp with enclosed diffusing shade placed on top of receiver or lighting from behind receiver will provide good viewing conditions.
Writing Room	7	1–2	0.5–1	General diffusing fittings, with local lighting for individual tables, e.g. table lamp with 100-watt lamp in diffusing shade.

Location	Illumination lm/ft²	Approx. watts per sq. ft. Tungsten	Fluorescent	General Remarks
Ladies' Hairdressing and Beauty Salon	20	4–5	2–3 De Luxe W/W	Decorative diffusing fittings sited to illuminate each chair position from three sides. Dyeing and tinting areas where colour rendering is important may require colour matching tubes, if De Luxe warm white not acceptable. Wall brackets and glazed features for additional decorative effect. Ensure adequate lighting in front of mirror.
Turkish Bath	7	1–2	0.5–1	General diffusing fittings with porcelain gallery and gasketed diffusing glass.
Nursery	10	2–3	1–2	General diffusing fittings fixed well out of reach.
Surgery	20	4–5	2–3	General diffusing fittings with local lighting over examination couch.
Staff Areas				
Kitchens Preparation Rooms Serving, Pantries, etc.	15	3–4	1–2	*Tungsten* Vitreous enamel or vapour-proof. *Fluorescent* Vitreous enamel *OR* acrylic : natural colour tubes suitable. Supplementary lighting from inside ventilator hoods over kitchen ranges is desirable but fittings should be vapour-proof. Local lighting may be required for specialised machines.
Cold Store	7	1–2	0.5–1	*Tungsten* Porcelain type with diffusing glass. *Fluorescent* Enclosed type, with anti-corrosive metal-work, special low-temperature circuit available for temperatures below 32 deg. F.
Wine Cellar	7	1–2	0.5–1	As above. General lighting down main gangways with points between subsidiary racks switched locally.
Boiler House Switch Room Air Conditioning and Vent. Plant Room Lift Room	7	1–2	0.5–1	Usually vitreous enamel industrial dispersive reflector. Bulkhead fittings for wall mounting. Fluorescent fittings should not be used in ambient temperature above 86 deg. F.
Battery Room	7	1–2	—	Porcelain/glass non-corrosive fittings.
Telephone Exchange	15	3–4	1–2	General diffusing fittings positioned to avoid specular reflections on switchboard. Supplementary lighting of vertical surfaces of switchboard desirable.
Laundry				
Washing	7	1–2	0.5–1	Vapour-proof vitreous enamel or acrylic fittings. Ultra-violet lamps required for marking.
Checking Pressing Sorting Ironing	20	4–5	2–3	

Location	Illumination lm/ft²	Approx. watts per sq. ft. Tungsten	Fluorescent	General Remarks
Electricians Carpenters Cabinet makers Plumbers Painters	15–20	3–4	1–2	Robust industrial type fittings positioned to suit bench arrangement. Lathes, drilling machines, etc., may require local lighting.
Silversmith's and Plating Shop	20	4–5	1–2	Non-corrosive industrial type fittings with local lighting for polishing heads.
Tailor's Shop				
General	7	1–2	0.5–1	General diffusing tungsten fittings: colour matching fluorescent tubes in open-top trough: local lighting as required.
Sewing	30			
External Areas				
Car Park	0.5	0.1–0.2	0.1	Vitreous enamel wide angle floodlights; alternatively similar fittings with colour corrected mercury lamps or fluorescent lanterns.
Garage				
Repairs	20	4–5	1–2	Industrial fittings preferably vitreous enamel with upward light, positioned to suit bench arrangement. Inspection pit lighting and petrol storage areas may require flameproof equipment.
General	3	0.5	0.2	
Gardens and Terraces	(Up to)1	0.1 to 0.2	0.1	Decorative lanterns and coloured floodlighting in flower beds and trees. All equipment should be robust and weatherproof.
Fountains	—	—	—	Underwater floodlighting by means of submerged fittings, tungsten or fluorescent—a colour change will increase decorative effect.
Tennis Courts	15	—	—	For single courts five 1,000-watt vitreous enamel angle reflectors down each side mounted 18 to 20 ft. high. For multiple courts, five down each side and one column carrying four fittings on central line between courts.
Swimming Pool	5	1	0.5	Non-corrosive floodlights mounted on building structure or on columns. Underwater lighting will provide decorative effects and safety value.
Approach Road and Entrance	—	1.0 to 1.5 watt per ft. run of road	0.5 to 1.0 watt per ft. run of road	Decorative tungsten or fluorescent roadway lanterns on 15 ft. high columns. Post-top lanterns for entrance.
Facade	1–10	0.5–1	0.2–1	Floodlit in colour to contrast with adjacent street lighting. Many types of discharge lamps available. An illuminated sign would be an added attraction.

Discussion

Mr. F. MASSEY : New hotels in this country are a rarity and, as far as I know, since the war only three new hotels have been constructed here. We can therefore assume that nearly all hotels were wired in the days when the rule was three or even one light per bedroom and the lighting in the kitchens and service quarters widely spaced. The trend today, however, is one of constant "uploading." More points, more watts per point, and more outlets.

Outlets nowadays are used for a wide variety of things apart from lighting—things like vacuum cleaners, portable heaters, radios, razors, tape-recorders, etc. When the hotelier has the opportunity he will redecorate and refurbish his bedrooms; a double room with a bathroom today requires about ten lighting points and at least two outlets and if installing these means interfering with the decoration the cost would be about £5 a point. That is quite an item to add to a budget for redecorating.

I have heard it said by architects and decorators that this country is a long way behind the Continental countries in the field of decorative fittings. But we have not had too much scope. Whereas on the Continent, particularly in Germany, hotels have been rebuilt and redesigned since the war, very little has been done here.

I think it is about time we had a neat fluorescent fitting for bedrooms. A small fitting would lower the installation costs as well as the running costs. The authors have said quite a lot about flex—I abhor the use of flex, even in private sitting rooms or bedrooms. Designers should also endeavour to keep bracket lights away from walls so that wall marking does not occur.

I am sure a wider use of cold cathode lighting would have been made in hotels if it were cheaper to instal. Some of the lampholders I have seen on otherwise good fittings have been very poor and this can lead to expensive maintenance.

There is one point about the kitchens and service quarters. I have found, generally, that fluorescent lighting is very satisfactory—usually "warm white" in the kitchens themselves and a colder white in the larders—to the complete satisfaction of the chef and his staff.

With regard to lifts, I once saw an old plan on which the lift was described as a "rising room" and I think a lift should be lighted as such. Cornice lighting appears to me to be a good way to do this. The lift is really part of the entrance hall and is part of the journey that guests make from the entrance hall to the bedroom.

I would make a plea to designers to try to put sufficient light in the corridors of hotels to enable the visitors to read the room numbers and find the keyhole.

The manager of a hotel has to be concerned with the safety of his guests throughout the day and night and bearing this in mind the lighting fittings in a hotel should, as far as possible, be non inflammable and not too heavy.

Finally, I do think the paper will make a good reference for anyone who is interested in the subject of hotel lighting, particularly managers and their engineers.

Mr. H. CARPENTER : The authors have suitably emphasised the fundamentals of hotel lighting—the blending of the functional and the decorative. Whether the engineer should be the one to look after the functional and the architect the decorative, or vice-versa, I don't know! The essential thing in an hotel is to create an attractive impression and the character of the lighting has to be considered. Lighting should merge and blend with the decor and generally be unobtrusive whilst performing the necessary functions.

Showcase lighting is a point of interest, because the mere male must have something in the corridor to keep him interested whilst waiting for his lady. The cost of the lighting here can be a commercial proposition, for the object of the showcase is to sell the goods displayed, and it is known that the rentals for these displays can make an appreciable contribution towards the overheads.

In regard to flexible cables, I am entirely in agreement with the authors. Flex is not only unsightly—it is a nuisance. For restaurant lighting it is essential that you light the table—it is a functional necessity—and I wonder whether thought has ever been given to a table standard with a built-in secondary battery? It would have a heavy base that is not easily knocked over, and could be easily charged, by a simple plug-in method, and would do away with the necessity for trailing flex. Lower off-peak electricity tariffs, for night charging, might be an additional benefit?

Mr. A. G. PENNY : I would like to say a word about maintenance. In these days we hear a lot about "planned maintenance," "group replacement schemes" and other plans for reducing maintenance costs. These are all very well where everything is foreseeable, as in a streetlighting installation or perhaps, a factory, but in hotel lighting there is an obvious difficulty in that the lighting required for various rooms will be in use for widely differing periods, frequently unpredictable. A light in the entrance hall may be burning

for anything up to eighteen hours a day whereas a light in a bedroom or vestibule may be on for only a matter of seconds. Most hoteliers find that the only practicable way of maintaining lamps in hotel lighting is to leave them in until they cease to give light. Under these conditions it is important that the lamp should maintain its light output at a high figure. The ordinary coiled-coil gasfilled lamp is therefore very satisfactory for hotel use, as at the end of its life it will still be giving over 90 per cent of its initial light output. It compares very favourably with such special types as vacuum candle lamps which are often favoured by hoteliers but which by the end of their life may well give little more than half their initial performance. At the same time, it must be admitted that the candle lamp is much better at creating a desirable " atmosphere " than is the gasfilled lamp. I suggest that it is high time members of the I.E.S. found out how to provide the hotelier with electric lighting having the character of wax candles and the economy which should go with the use of electricity.

Mr. R. J. Fothergill : It isn't perhaps generally realised that this subject is a particularly important one from a national point of view. If the authors had used the term " dollars " instead of " pounds " it would have been realised that tourists bring in more trade to this country than the motor car and whisky industries put together.

The Authors (in reply) : When we commenced the preparation of this paper we soon realised that there would be very little difficulty in criticising some of the lighting arrangements seen in different hotels, but in many instances it was not going to be easy to make constructive suggestions which would be acceptable to all parties. Lighting systems, which may well be pleasing to the guests, often introduce installation problems which are of direct interest to architects, interior designers, hotel managers and their maintenance staffs. This perhaps particularly so when the older hotels are being refurbished. Consequently some compromises have been suggested and we hope that the paper will set people thinking and lead to more interesting lighting than has sometimes been seen in the past.

Mr. Massey has referred to the present-day trend of " uploading " and the difficulties of meeting this with existing wiring systems. The improvements which have taken place in recent years in the development of fluorescent tubes which produce what one might call " social " or " recreational " light may well lead to their wider use in guest areas and so enable more light and perhaps a better distribution to be obtained with little or no increase in current consumption. There should, for example, be no difficulty in designing a suitable fluorescent fitting which could be used in a bedroom. Manufacturers may consider a design of fitting for some types of built-in furniture which would enable different areas to be lighted by adjusting a simple type of reflector and so assist in reducing the lighting load by making one fitting serve a dual purpose.

While, of course, we fully sympathise with the comments which have been made in the discussion about the strong dislike of flex, we should like to suggest that an improved type of flexible lead, especially for table and floor standards, would probably eliminate many of the troubles hitherto experienced. Plastic covered flexible cords would appear to present fewer hazards than cotton covered flexible cords.

It is regrettable to hear that extra work is being thrown on the maintenance staff in hotels through the use of inferior quality lampholders ; we hope that complaints of this nature are always brought to the notice of those responsible for specifying or purchasing lighting fittings and so ensure that the use of inferior lighting equipment is strongly deprecated.

Mr. Massey's reference to the lift being part of the entrance hall recalls to mind a design used at the Statler Hilton Hotel, Dallas, where each lift is in fact a small replica of the entrance hall, with all essential characteristics in common.

The suggestion made by Mr. Carpenter for a table lamp with built-in secondary battery appears to be well worth further consideration. Such a lamp would be welcomed by the hotel management for lighting individual tables in dining rooms. Table lamps with a heavy base are already used in ocean going liners but there the heavy base has been provided to ensure some stability ; there does not appear to be any reason why a similar base should not be adapted to accommodate a secondary battery.

We agree with Mr. Penny's comments on the need for a means of producing efficient electric lighting which has the character of the wax candle. Such attempts as have been made with gasfilled lamps very often bear little or no resemblance to a genuine wax candle and the solution may well be in the hands of the physicist responsible for lamp development.

It is interesting to recall, in support of Mr. Fothergill's statement, that in addition to tourism being Britain's prime dollar earner, it has been recorded as being the sixth most valuable export.

UDC 628.973

Lighting and Architecture

By G. GRENFELL BAINES, A.R.I.B.A., Dip.T.P., A.M.T.P.I. *(Member)*

and A. L. HOGG, A.M.I.E.E. *(Member)*

Summary

This paper underlines the implications of the now widely-accepted fact that lighting design is an integral factor in architectural design. Post-war lighting developments and a number of lighting schemes are reviewed and successes and failures are discussed. Fittings designs are also examined. The practical problems of architect-engineer collaboration are discussed. The paper concludes with some suggestions on future design developments and possible lines of joint action between lighting engineers and architects.

While substantial, and often spectacular, developments in lighting have been taking place in the ten years which have elapsed since last we discussed architecture and lighting with your members, the nature of architecture and the principles of design in building have remained, and will remain, unchanged. This does not imply that designers of buildings have not been producing new ideas for working out these immutable principles. On the contrary, there is substantial evidence in city and countryside of new thought in architecture. Since the war, designers of buildings have made substantial advances in consolidating the new approach to architecture which began in Great Britain about fifty years ago but which was only showing signs of gathering momentum when the war practically stopped the sort of thinking about building which might have led to machine-age architecture. For architecture is building *plus*. It has been for thousands of years, it is to-day, and will be.

Our definition of architecture, therefore, remains the same; shelter with grace. Of necessity the grace that invests a building design will vary with circumstances; often it is a matter of money, though not always are the most expensive buildings architecture.

Buildings which perform their primary function of sheltering some human activity, and do so in a way that pleases the eye and evokes emotion, display themselves in two ways. Firstly, by their outer forms, which are seen mainly in daylight as a single effect of mass or related group of masses against a background of townscape, landscape or sky. Secondly, by their inner spaces, of which there may be many. In both cases these effects of mass and space are built up by surfaces of varying dimensions. In towns, the proximity of buildings can create special effects of space, as in the case of London squares, village streets, or St. Mark's Place in Venice. Human beings seem to be equipped with a built-in radar-like sense of space, the sensibility range of which can vary from the exhilaration (or fright) of being on the edge of a high cliff, to a sense of cosiness (or claustrophobia) from being in a small room.

As lighting engineers are mainly concerned with the internal spaces of buildings and as yet do not work much within the internal space of towns, this paper will deal mainly with interiors. This is not to ignore the tremendous amount of thought that has gone into street lighting and the floodlighting of buildings; though in passing it must be said that, as yet, development of light sources and methods of controlling light for streets has not reached anything like the stage at which engineers could feel innocent of the charge of "polluting space" which was levelled ten years ago when discussing interiors. On the other hand, it is precisely those recent developments in producing, and particularly controlling, light which have done much to enable engineer and architect alike to light their interior spaces without cluttering them up in a way which disturbs, and even destroys, the effects originally intended.

Visual satisfaction, which is generated and sustained by this emotional capacity to react to shapes and spaces, depends on relations between the dimensions of the enclosing surfaces. There are no cast-iron formulae for ensuring architectural merit; and even the engineer, who can predict so many things by formula, must admit that there is a divinity beyond all calculation and prediction which gives his scheme the spark. On the other hand certain "coincidences of circumstance" have become established over the ages, and certain characteristics of shape and groupings of shapes have been seen over and over again to be thrilling, dull, or somewhere between. It must

The authors are with Grenfell Baines & Hargreaves. The manuscript of this paper was first received on March 24, 1958. The paper was presented at a meeting of the Society at Eastbourne on May 14, 1958.

be admitted, however, that the situation is liable to be confused at any time by fashion. Some years ago we came to the end of an era in which symmetry had been fashionable and there followed a period in which one strove for asymmetry on every conceivable occasion. To-day there is a healthier attitude which admits of either if the circumstances of the problem require it; indeed it may be said there is more building design " from the inside out " to-day than at any time since the beginning of the century.

It is not necessary to discuss in detail what particular characteristics of shapes are evocative, but it is necessary for the lighting engineer to realise that it is on this relationship of length to breadth to height that the effect depends, and any effect of light which changes these relationships has a corresponding effect on the proportions of surface and space. This change may not always be for the worse, for many of the spaces in buildings to-day are governed entirely by function and economics and this can by no means be relied upon to result in a graceful effect. Function and economics are two important factors of design but a well-balanced work of architecture is a fusion of these with structure and beauty.

If then the natural outcome of providing space for purpose and economy does not necessarily give graceful proportions, what may the designer do? Before trying to answer this question it is necessary to distinguish between what may be termed " traditional " and " modern " architecture and to touch on the nature of the light which reveals these architectural characteristics. It has been said that architectural effects depend on the capacity of outer forms and inner spaces to inspire emotional and visual reactions. The emotional reaction arises from a space sense that is not entirely visual. One can walk from a small low space into a large high space with eyes closed, and, aural effects apart, there are other effects which tell unmistakably of the change. However, the visual component is mainly responsible for stimulating the reaction of the whole being, and here obviously is where the light comes in—or rather the light and the shade, for form cannot exist without shadow.

For many centuries buildings were designed for their forms and spaces to be revealed by daylight. Further, it was not a matter of fashion or accident that " traditional " architectural effects were often rich with incidental elements, details, ornament and moulding. In addition to a social conception of architecture as an end in itself (whether glorifying God or man) in which human beings were mere foils to their own achievements, there was every technical reason for building to be full of detail and incident. The principal materials, stone, wood, and brick, could only be put together in a multitude of components—pillars, beams, arches, buttresses, corbels, trusses. Thus, part of the architectural effect derived directly from the make-up of the structure. After their general assembly by hand, stone and wood lent themselves to carving and moulding into cornices and friezes which, by their strong lines of light and shade, gave emphasis to the extremities of surfaces, thus adding to the significance of their contribution to the general shape of the room. Further, social conditions and the pattern of industry, in which—apart from agriculture and textiles—building was supreme, allowed both time and labour not only for these basic mouldings to be carved but for elaborate ornamentation of the mouldings themselves.

In the same way it is no matter of fashion or accident that the lean and clean, spare and bare lines of the architecture we see to-day are a reflection of the society and times in which we live. A drastic change in the pattern of industry (which has greatly increased the proportion of people in other industries while reducing that in building), a tremendous increase in social ambition (which has led to a corresponding increase in the demand for more houses, schools, hospitals, factories and so on)—these two opposite forces have stretched the labour and material resources of building, reducing spaces, lowering ceilings, planing away detail and enrichment, sweeping away domes, towers, pinnacles and other ingredients of silhouette. People will not pay for them, so they do not get them—it is as simple as that.

Fortunately the techniques of the building industry have adapted and developed to meet the circumstances; but here again, not surprisingly, the visual effects are in harmony with those brought about by the social conditions which developed them. Floors and roofs are carried by steel and concrete over greater spaces. Pillars are fewer, whilst walls are lighter; sometimes all glass, to add the effect of one space to another, and outer space to both. Surfaces are simpler and enrichment comes from large areas of natural materials, textures, the daring use of colour, natural plants, and machine-made patterns in textiles. Though structural members may be fewer and lighter than in the past, structure can still make a considerable contribution to architectural effect. Some of the latest shell and rib constructions in concrete have all the excitement of the Gothic. With these technical changes has come about a marked change in the social

character of building which, from dominating the scene, has now become more of a background at the service of its human users. Thus, inspiration for aesthetic effect derives from truthfully expressing purpose and structure, and it can be said without being in any way complacent that present-day building design is in a much healthier state and more in tune with the age than the design of 100 years ago.

Both old and new buildings need light to reveal their forms, but whereas the high spaces of old buildings can absorb a certain amount of pollution —even be spiced or flavoured—by hanging objects, the reduced spaces of modern buildings are, not surprisingly, more suited to built-in lighting. This is only one aspect of the situation, but it is important to remember that the visual effect of fittings during the day is as important as their use at night. It may be noted that since inventing the term "space pollution" another term—"spicing space"—has been coined—this represents the limit of permissibility; as in cooking, it is the supreme artist who knows how far to go in flavouring the dish. Perhaps one of the finest dishes of this kind ever enjoyed was the interior of the Lion & Unicorn pavilion of the South Bank Exhibition where a cloud of plaster doves was suspended in space by almost invisible piano wires over a part of the pavilion. Chandeliers in the high spaces of churches, entrance halls and public rooms, and simple circular shades over dining tables in modern homes may do the same, but in small modern interiors it is easy to spoil the space with no more than a pennorth of fitting. More will be said about developments in the design of lighting fittings, but having discussed the nature of architecture, its reliance on space surface and structure for expression, we may now examine the characteristics of light which reveal these effects, as seen by the architect.

While imitations of daylight are to be condemned —not particularly on account of the dubiety of imitation as such, but because straight imitation of daylight would deny artificial light the development of its own expression—there are good reasons for looking once more at the characteristics of daylight, for it must be admitted there are many spaces which look extremely well in daylight, lively in surface, significant in form and which yet seem to lack all life and cohesion when lighted at night. Desirable characteristics of daylight are uni-direction: variety (up to glare point), diffusion (from northern skies), and spacial purity. To point out that the great difference between daylight and artificial is that the first comes in from outside while the second comes out from inside seems so obvious as to provoke the retort—"So what?" But from this "So what?" to "Know how" stretches a gulf the bridging of which may lead to new lines of development in lighting which could turn technique into art. Firstly, light coming in from outside must, of necessity, be directional and so more effective in revealing form. On the other hand, light sources inside a space, especially when they are designed to produce even illumination, will by absence of shade conceal form. Variety and uni-directional light go together, dullness and multi-directional light go together. To some extent this is another way of putting the previous paragraph, except that the variety of daylight enriches its revelation of form. The coming and going of the sun—"like the turning of a rheostat," as Steinbeck describes it, and its changes of direction, reveal new forms in the same space, which, while not to be imitated, give valuable clues.

There has been too much "pastel" lighting up to now. Architects moved away from pastel colour schemes twenty years ago—this was easier, for colour is easier to control, but now that the lighting engineer has developed linear as well as point sources, with reflectors and louvres to control light, the means for bold varied lighting effects are at hand.

The other two qualities of sunlight—diffusion and purity of space—are within the grasp of the engineer, the former by the means of control just mentioned, the latter either by built-in or by surface-mounted devices; while, as already said, there is no reason why some spaces may not be as excitingly enriched by well-designed suspended objects as by a slanting ray of sunlight. Direction and variety might be the real beginning of lighting in harmony with architecture, because it is in harmony with the purpose of architecture—form and surface.

And now, having examined the nature of architecture and the characteristics of daylight which might inspire artificial lighting, we may return to the problem of the designer who is faced with a space which, though designed to meet functional and economic requirements, does not possess graceful proportions. Generalities on subjective matters are dangerous, for there can be no formulae which will churn out the results for aesthetics, but it has been noticed that contrast is a desirable quality in design. When applied to the proportions of the surfaces which form a space perceptible differences between length and breadth and between these and height, between smooth and rough textures, between light and dark tones—any or all of these can evoke interest, and possibly

be admitted, however, that the situation is liable to be confused at any time by fashion. Some years ago we came to the end of an era in which symmetry had been fashionable and there followed a period in which one strove for asymmetry on every conceivable occasion. To-day there is a healthier attitude which admits of either if the circumstances of the problem require it; indeed it may be said there is more building design " from the inside out " to-day than at any time since the beginning of the century.

It is not necessary to discuss in detail what particular characteristics of shapes are evocative, but it is necessary for the lighting engineer to realise that it is on this relationship of length to breadth to height that the effect depends, and any effect of light which changes these relationships has a corresponding effect on the proportions of surface and space. This change may not always be for the worse, for many of the spaces in buildings to-day are governed entirely by function and economics and this can by no means be relied upon to result in a graceful effect. Function and economics are two important factors of design but a well-balanced work of architecture is a fusion of these with structure and beauty.

If then the natural outcome of providing space for purpose and economy does not necessarily give graceful proportions, what may the designer do? Before trying to answer this question it is necessary to distinguish between what may be termed " traditional " and " modern " architecture and to touch on the nature of the light which reveals these architectural characteristics. It has been said that architectural effects depend on the capacity of outer forms and inner spaces to inspire emotional and visual reactions. The emotional reaction arises from a space sense that is not entirely visual. One can walk from a small low space into a large high space with eyes closed, and, aural effects apart, there are other effects which tell unmistakably of the change. However, the visual component is mainly responsible for stimulating the reaction of the whole being, and here obviously is where the light comes in—or rather the light and the shade, for form cannot exist without shadow.

For many centuries buildings were designed for their forms and spaces to be revealed by daylight. Further, it was not a matter of fashion or accident that " traditional " architectural effects were often rich with incidental elements, details, ornament and moulding. In addition to a social conception of architecture as an end in itself (whether glorifying God or man) in which human beings were mere foils to their own achievements, there was every technical reason for building to be full of detail and incident. The principal materials, stone, wood, and brick, could only be put together in a multitude of components—pillars, beams, arches, buttresses, corbels, trusses. Thus, part of the architectural effect derived directly from the make-up of the structure. After their general assembly by hand, stone and wood lent themselves to carving and moulding into cornices and friezes which, by their strong lines of light and shade, gave emphasis to the extremities of surfaces, thus adding to the significance of their contribution to the general shape of the room. Further, social conditions and the pattern of industry, in which—apart from agriculture and textiles—building was supreme, allowed both time and labour not only for these basic mouldings to be carved but for elaborate ornamentation of the mouldings themselves.

In the same way it is no matter of fashion or accident that the lean and clean, spare and bare lines of the architecture we see to-day are a reflection of the society and times in which we live. A drastic change in the pattern of industry (which has greatly increased the proportion of people in other industries while reducing that in building), a tremendous increase in social ambition (which has led to a corresponding increase in the demand for more houses, schools, hospitals, factories and so on)—these two opposite forces have stretched the labour and material resources of building, reducing spaces, lowering ceilings, planing away detail and enrichment, sweeping away domes, towers, pinnacles and other ingredients of silhouette. People will not pay for them, so they do not get them—it is as simple as that.

Fortunately the techniques of the building industry have adapted and developed to meet the circumstances; but here again, not surprisingly, the visual effects are in harmony with those brought about by the social conditions which developed them. Floors and roofs are carried by steel and concrete over greater spaces. Pillars are fewer, whilst walls are lighter; sometimes all glass, to add the effect of one space to another, and outer space to both. Surfaces are simpler and enrichment comes from large areas of natural materials, textures, the daring use of colour, natural plants, and machine-made patterns in textiles. Though structural members may be fewer and lighter than in the past, structure can still make a considerable contribution to architectural effect. Some of the latest shell and rib constructions in concrete have all the excitement of the Gothic. With these technical changes has come about a marked change in the social

character of building which, from dominating the scene, has now become more of a background at the service of its human users. Thus, inspiration for aesthetic effect derives from truthfully expressing purpose and structure, and it can be said without being in any way complacent that present-day building design is in a much healthier state and more in tune with the age than the design of 100 years ago.

Both old and new buildings need light to reveal their forms, but whereas the high spaces of old buildings can absorb a certain amount of pollution —even be spiced or flavoured—by hanging objects, the reduced spaces of modern buildings are, not surprisingly, more suited to built-in lighting. This is only one aspect of the situation, but it is important to remember that the visual effect of fittings during the day is as important as their use at night. It may be noted that since inventing the term "space pollution" another term—"spicing space"—has been coined—this represents the limit of permissibility; as in cooking, it is the supreme artist who knows how far to go in flavouring the dish. Perhaps one of the finest dishes of this kind ever enjoyed was the interior of the Lion & Unicorn pavilion of the South Bank Exhibition where a cloud of plaster doves was suspended in space by almost invisible piano wires over a part of the pavilion. Chandeliers in the high spaces of churches, entrance halls and public rooms, and simple circular shades over dining tables in modern homes may do the same, but in small modern interiors it is easy to spoil the space with no more than a pennorth of fitting. More will be said about developments in the design of lighting fittings, but having discussed the nature of architecture, its reliance on space surface and structure for expression, we may now examine the characteristics of light which reveal these effects, as seen by the architect.

While imitations of daylight are to be condemned —not particularly on account of the dubiety of imitation as such, but because straight imitation of daylight would deny artificial light the development of its own expression—there are good reasons for looking once more at the characteristics of daylight, for it must be admitted there are many spaces which look extremely well in daylight, lively in surface, significant in form and which yet seem to lack all life and cohesion when lighted at night. Desirable characteristics of daylight are uni-direction: variety (up to glare point), diffusion (from northern skies), and spacial purity. To point out that the great difference between daylight and artificial is that the first comes in from outside while the second comes out from inside seems so obvious as to provoke the retort—"So what?" But from this "So what?" to "Know how" stretches a gulf the bridging of which may lead to new lines of development in lighting which could turn technique into art. Firstly, light coming in from outside must, of necessity, be directional and so more effective in revealing form. On the other hand, light sources inside a space, especially when they are designed to produce even illumination, will by absence of shade conceal form. Variety and uni-directional light go together, dullness and multi-directional light go together. To some extent this is another way of putting the previous paragraph, except that the variety of daylight enriches its revelation of form. The coming and going of the sun—"like the turning of a rheostat," as Steinbeck describes it, and its changes of direction, reveal new forms in the same space, which, while not to be imitated, give valuable clues.

There has been too much "pastel" lighting up to now. Architects moved away from pastel colour schemes twenty years ago—this was easier, for colour is easier to control, but now that the lighting engineer has developed linear as well as point sources, with reflectors and louvres to control light, the means for bold varied lighting effects are at hand.

The other two qualities of sunlight—diffusion and purity of space—are within the grasp of the engineer, the former by the means of control just mentioned, the latter either by built-in or by surface-mounted devices; while, as already said, there is no reason why some spaces may not be as excitingly enriched by well-designed suspended objects as by a slanting ray of sunlight. Direction and variety might be the real beginning of lighting in harmony with architecture, because it is in harmony with the purpose of architecture—form and surface.

And now, having examined the nature of architecture and the characteristics of daylight which might inspire artificial lighting, we may return to the problem of the designer who is faced with a space which, though designed to meet functional and economic requirements, does not possess graceful proportions. Generalities on subjective matters are dangerous, for there can be no formulae which will churn out the results for aesthetics, but it has been noticed that contrast is a desirable quality in design. When applied to the proportions of the surfaces which form a space perceptible differences between length and breadth and between these and height, between smooth and rough textures, between light and dark tones—any or all of these can evoke interest, and possibly

pleasure. A room that is a cube in shape, though its surfaces are made of squares which in themselves are a significant shape, makes yet a dull volume; on the other hand the "double cube" is known to be a graceful shape of classic proportions though static rather than dynamic in character, suitable for a state reception room rather than a primary school assembly hall.

These qualities of monumentability or informality—the static or the dynamic—depend very much for their effect on the dimensional differences of the surfaces which give "directions" to a design. It has been said that a perfect square gives a great sense of stability appropriate to the great occasion. A tall shape on end—as the cross section of a cathedral, has a pronounced vertical direction which is immediately evocative and recognisable as appropriate. The Norman arch which is a perfect semicircle sweeps round with majestic *stability*. Increasing the rise without increasing the width produces a lancet or pointed arch, well known as one of the vital elements contributing to the *moving* soaring quality of Gothic architecture. Many other demonstrations of varying aesthetic effects produced by relationships of the dimensions of surfaces could be quoted. The essential point is that surface makes space and space makes form; the outcome of lighting space, therefore, must result in the secondary pattern of light and shade being at best in harmony with—and, at worst, not destructive of—surface character. Lighting should aim at defining the junctions between surfaces rather than blurring them as so much light produced inside a space is apt to do. Perhaps the worst illustration of light and shade destroying surface character is that provided by the suspended shallow-bowl-type fitting to be found in many a living-room—shadows often with hard edges sweeping from wall to ceiling cutting off the corners of both and destroying the effect of surface and form. Another example is the over-liberal use of cornice lighting which completely detaches the ceiling from the walls. There are cases of modern architecture where this effective detachment is in harmony with the spirit and may even be deliberately sought; but practically all traditional architecture relies for effect on continuity; wall rises to meet entablature, cornices and coves flow upwards to meet a ceiling in stability. Breaking down this effect eventually produces incongruity.

While secondary patterns of light and shade are important, colour is used by the architect to develop his forms. It may be used to correct unsatisfactory proportions which result merely from function and economy. Thus colour is also part of the answer to the question posed earlie in the paper. It will readily be appreciated tha the designer may use colour to "orchestrate" a original form theme. The lighting engineer an the architect working together may also us colour to control otherwise uncontrollable lightin effects which themselves may arise purely fro function and economy. For example, where th pattern of light unavoidably overlaps a wall an ceiling surface, the junction between the two ca be defined by colouring one or other of th surfaces in a deep colour of low reflectance thu simultaneously sharpening the effect of form whil correcting the effect of light. The advancing an receding properties of colours are well known, an the use of these properties to adjust proportion by causing, say, the end walls of long rooms t be coloured in warm advancing colours, or the ceilings of low rooms in cool receding colours is well established.

In these days, for the economic reasons already stated, architects who are unable to provide traditional ornament will rely on textures over large surfaces. The effect of texture, depending entirely on light and shade, requires directional light. Here again integrity of the surface pattern is vital, and if colour cannot be used as a means of control then the light should be well contained on the surface; or, should it be necessary for the pattern to flow near to the edge, the boundary between light and shade should be a soft line.

The use of a highly reflecting colour, such as white, to emphasise the patterns of interesting structural systems—another way of introducing a decorative note into building today—again requires directional light, to reveal not only the form of the structure, but possibly to create interesting shadow patterns on adjoining surfaces. This possibility is worth noting, as the deliberate introduction of controlled shadow patterns may make just as effective a contribution to the overall result as the light itself. Indeed, we have come to the conclusion that an ideal scheme of interior lighting would deliberately create different intensities of light and shadow on opposite walls while compensating for different levels at the working plane either by lights sunk into the ceiling with a strong punch downwards, or by local standards and small fittings. All this obviously calls for more detailed lighting specifications by the architect, and his present instructions to painters and decorators on colour are a model o the sort of information the lighting enginee should have. It also requires more informatio on the performance of reflection and light source in building up a complete pattern. It could impl

closer collaboration when designing for natural lighting effects. In particular, the results of inter-reflection could be explained by the engineer, and thus modify and inspire window design and consequently architectural expression.

The effects, both on basic architectural form and surface treatments, brought about by a better knowledge of acoustics, illustrate the possibilities of a better knowledge of lighting in the architect, which would lead to a higher degree of collaboration with the engineer.

Reduced spaces and the need to give softer lighting effects have led to the use of lighting sources attached to walls and ceilings. The deliberate shaping of ceilings and walls into attached fittings takes matters further to built-in lighting, perhaps the most significant development of which is the louvred ceiling, virtually a lighting fitting equal to the whole area of the room. The principal effect of this is to almost destroy any sense of enclosure. This may be accepted under certain conditions; on the other hand, it is very necessary to decide whether it is desirable for the surrounding walls of a room to appear like detached pieces of scenery without any visible means of connection. Schemes where a proportion of ceiling area is thus treated may be even more disastrous, particularly where the amounts of lighted and shaded ceiling are roughly equal, destroying any effect of design or unity.

Rules for installing lighted panels in ceilings are very much the same as those for installing windows in walls; there must be clear dominance of one over the other. Complete lighting of ceilings seems to be most appropriate in foyers, vestibules, and similar spaces, which link the inner rooms of the building with the outer air. For inner rooms themselves completely lighted ceilings seem only to be appropriate in a limited number of cases, such as large drawing offices, laboratories, and possibly parts of shops. The chief drawback of these schemes is their coldness, because the lighting lacks variety (which may be appropriate in a drawing office) and bright as it may be, it is open to the criticism of "pastel lighting." In spite of the brilliant contrast between "star lights" set in a dark ceiling, if this is the sole means of lighting and the points are evenly distributed, the same "pastel" effect results though now the junctions between wall and floor are obscured, with the consequent loss of form. Thus, the same rules of direction and variety should be strongly borne in mind even when using attached fittings or completely built-in lighting schemes.

An important element of post-war lighting is the design of fittings themselves. Many with simple, almost sculptural character, whether singly or in groups, are capable of enriching space without in any way detracting from the main architectural effect. Great improvements in fittings brought about in the thirties have continued steadily since the war and there are to-day dozens of simple fittings almost negative in character (though superbly designed) at the disposal of engineer and architect. Drastic reductions in the bulk of suspension also helps in handling space, while the complete detachment of suspension and conductor, allowing the former to be of thin piano wire and the latter to be gracefully festooned from some low level of the wall, not only make a direct "fitting scheme" attractive in space but, particularly in the case of high compartments like churches, much easier to wire and maintain. It is not necessary to employ symmetrical schemes of detached fittings; indeed, to do so might destroy the light and shade effects required to reveal form. Adjustments to the dispersive functions of a fitting can vary the direction and intensity of light emission and perhaps the most successful and interesting example of this lighting approach is that already described to many of you by Mr. J. M. Waldram.

We have all of us experienced at one time or another being in a building which is used for some purpose other than that for which it was designed and the almost invariable feeling of "make-shift" which accompanies it. Similarly with lighting installations—the lighting must be integral with the building or the feeling (whether conscious or sub-conscious) of "make-shift" will still be evident. How can a lighting installation be provided that is integral with a particular building? The architect "sees" a building complete before he produces any design drawings. The engineer must be given this picture, or the lighting will not belong to the building. Why is this?

We are all influenced by our own homes, schools, offices, shops, factories, etc., to such an extent that if an architect tells us he is designing, say, a house, we immediately think of our own homes, and similarly with any other type of building. Let us consider, for argument's sake, what would happen if an architect asked an engineer to provide a lighting scheme for a block of offices, the only information provided being a plan of the building with ceiling heights, reflection factors of walls, floors, ceilings, etc., and details of any special features such as wall charts, enquiry counters, etc. The lighting engineer would produce a good lighting scheme, but would it be integral with the building? It is most unlikely that it would be, because the lighting engineer would be influenced

by other schemes for similar types of offices. Generally, there is only one lighting scheme which will fit a given interior in order to create the environment for the function of the room. Lighting must never become the main feature of an interior but it must always enhance the interior. In many situations, such as rooms with very high ceilings, the fittings themselves become quite important features and their shapes and dimensions are all important. It is only by the closest co-operation between architect and engineer that the correct relationship between lighting and interior can be obtained. The ideal method would be for the architect to design his own lighting scheme. Buildings, however, are so complicated that it is not possible for the architect to design his own lighting so the engineer must be called in.

We suggest that the correct approach to the problem is for the architect and engineer to meet and have a full discussion about the building. The architect must get his feelings over to the engineer so that both are working on the same building. The architect " grows up " with his design and he must acquaint the engineer with his scheme at a very early stage in order to let the engineer also " grow up " with the design. Each architect has his own interpretation of a particular scheme and this personal interpretation must be given to the engineer, if a satisfactory result is to be obtained.

In addition to the discussion, the architect should prepare a specification of his requirements for the lighting engineer. This should give details of the type of lighting and fittings required, together with all relevant working drawings, including a schedule of finishes with colours of all the various wall, floor and ceiling finishes. For any rooms requiring special treatment, he should prepare a perspective sketch with, if possible, the various surfaces having the degree of brightness specified. This does not mean that the architect should give actual levels of illumination required, but that he should merely indicate the brightest feature with other surfaces marked say, " not quite so bright," or " half as bright," " darkest," etc. He should also sketch in his suggested fittings and furniture positions.

Lighting fitting manufacturers could assist the architect to select his fittings by providing, in their catalogues, brief details in simple language of the distribution of light, or light and shade patterns, of all the various fittings. This would enable the architect to select a standard type of fitting to suit his building.

The lighting engineer, armed with the architect's specification and with a mental picture of the building will then be in a position to design a lighting scheme which is an integral part of the building. The engineer usually produces a drawing indicating lighting point positions, switch positions and distribution equipment positions. This in itself is not very satisfactory as no indications are given of service runs, and when the work is undertaken the electrician is likely to find himself in conflict with ventilation, heating, water, telephones and a host of other services. This means, therefore, that the architect must act as director of operations and must indicate to the various specialists where their services shall run. The engineers in turn must then pass this information on to the contractor. There are two ways of doing this : (1) by drawings, and (2) by a detailed specification. To fully detail each individual cable or conduit run would result in an extremely complicated drawing, as large-scale plans, elevations and sections would be required. Therefore, both drawings and a specification must be prepared. The engineer's drawings should clearly indicate all lighting point positions, control points and main service runs. Notes should also be made on the drawing to assist the contractor who will eventually carry out the work. Special requirements and full details of wiring arrangements should be incorporated in a comprehensive specification. In many cases, the architect can indicate service runs on his large-scale detail drawings. Positions of all distribution equipment and controls must be very carefully determined in order to produce an economical installation which will not interfere with the building in any way. Finishes and styles of switches must be harmonious with the building. In addition to all the above points, the installation has to satisfy many technical requirements.

To recapitulate in conclusion—a lighting scheme has a functional aesthetic object to serve, the means of achieving a quantitative solution by effectiveness of light source and methods of control are undoubtedly at hand. Aesthetic requirements demand that space and surface must be respected ; that the structural expression shall be clarified and enhanced ; and that the whole shall be in harmony with the colour and texture scheme.

Discussion

Mr. H. HEWITT : The authors have made reference to many lighting topics and from their remarks we, as lighting engineers, can learn useful lessons. For instance, considerable reference has been made to totally luminous ceilings and those of us who are enthusiastic about this idea nevertheless realise its limitations. When I see an

installation of this kind which I think is unsatisfactory I try to explain its faults in technical terms—perhaps the brightness ratios are wrong, or the scene lacks shade or modelling. But when the authors deal with this idea they give us a new line of thought : when they refer to " pieces of scenery standing disconnected in space, destroying a sense of enclosure," their thoughts are helpful, and they justify their contention that totally luminous ceilings are most successful for those areas which connect with outer space.

During the last few years we in the Society have made efforts to bring lighting engineering and architecture closer together, and we have achieved some success. If we are to go further I believe we face two problems. One is that of trying to define a boundary between the activities of the lighting engineer and the activities of the architect. To judge from some of the comments in the paper the authors believe that the architect should specify almost in detail the effects he requires and even specify the type of fitting. I think I would be a little more ambitious for the lighting engineer. Although he is basically an engineer, he can be inspired with some of the imagination necessary for good lighting.

The second problem is the question of communication. I had a little difficulty in understanding some of the ideas put forward by the authors in their paper. The I.E.S. recently organised a series of lectures by architects and although this was very useful, there were times when I didn't understand what was going on. For instance, when an architect speaks of " plastic integrity " I must confess I don't know what he means. This problem is a real one and deserves attention from both sides. Lighting engineers have an important part to play—we have to appreciate, and partake in, the more artistic side of lighting and should not pretend that it is merely a technical exercise that can be solved by mathematics. But the architect should also learn to communicate clearly.

Mr. J. M. WALDRAM : I have been particularly interested in this paper because, as Mr. Hewitt said, the Society has been concerned with the question of collaboration between architects and lighting engineers ever since I can remember. We have for many years deplored the fact that, to quote Churchill, it has been " too little and too late." We are increasingly indebted to architects like Mr. Baines who have brought us closer together and have done much to resolve the basic difficulty hindering our collaboration, which is that of communication. We think and talk about the subject in different ways.

Mr. Baines has said a lot about the engineer and the architect and our joint work and collaboration and he mentioned directional lighting. Mr. Hewitt said we must beware of thinking that lighting is only a matter of calculation. I believe that calculation only enters into its own when you have decided what it is you want to do. Just recently there has been completed a job in which the architect and the engineer have been collaborating very deliberately : I have just been engaged on the lighting of Gloucester Cathedral. This probably involved more calculation and greater detailed planning than any similar installation, but it began with a study of the aesthetic and architectural effects and it made very careful use of directional lighting. The Cathedral is a very old building and obviously one in which the light and form have to collaborate if the architecture is to do its job, for architecture is " the marriage of light and form." You have to think first of all what the building is to be used for and not light it merely for the guide book.

Mr. A. E. GASTER : My work involves a lot of collaboration with architects, and the authors' view of the correct approach is far from academic. Whether the lighting scheme is designed initially by the engineer or the architect depends on the areas to be considered. For example, when we get a boiler house, a plant room or a control room, the functional aspect is vitally important. We, as engineers, know what light we want, where we want it and why we want it, and generally the architect will leave us to design that lighting. Nevertheless, we agree with the general theme so clearly laid down in this paper that the lighting should be integrated with the architectural features, and therefore even such an installation is still discussed by us with the architect. I have seen a boiler house with the lighting designed entirely by the architect, where most of the light was thrown on to the ceiling with very little light on the plant below where it is required.

On the other hand, where, as often, the major portion of the project is what I would call essentially architectural, we approach the architect and ask what he has in mind. The architect must understand that engineers are not necessarily Philistine and are not devoid of an element of aesthetic knowledge, understanding and feeling, and are quite able to discuss these matters with the architect and make their own suggestions and recommendations. Given an idea of what the architect wants, we interpret his requirements on the drawing board for subsequent further

discussion.

The authors raise objections to uniformity of light distribution. Consider a large office area, which may or may not be split into small or large rooms, and having a relatively low ceiling. With the present-day fashion of modular design, bearing in mind beams and columns, the positions of the lighting fittings are fixed and unalterable. With an illumination above, say, 20 lm/ft², fluorescent lighting is necessary to minimise the number of fittings, and to ensure that there is not too much heat generated. The only thing you can possibly do is to consider louvres, which can be mechanical or optical. I would say that the architects would in general prefer the optical louvres to give some sparkle. The result is a very uniform illumination. I would like to know from the authors if they have an alternative suggestion for such conditions.

Another difficulty is stairways. I have seen stairways lighted by a wall fitting on a landing, well covered by something which obscures most of the light, directed nowhere special, with no relation whatsoever to those paragraphs in the text-books as to how a stairway should be lighted.

The authors mention the word "space," and I would make one plea for plenty of space for the electrical services, which do not consist only of small conduit wiring, but often include a lot of heavy cabling and trunking.

Mr. D. R. H. PHILLIPS: Dr. Ballin in his paper on Lighting Trends made the following statement: "... the qualitative aspect which has had so much theoretical attention in recent years has made little progress ... for many visual tasks a higher level of illumination in itself, means also an improvement in quality." I thought it unnecessary to question these points in the discussion as I was convinced that any incorrect impression these may have caused would be rectified by this paper.

The present paper and that of Mr. Paivarinne have both indicated that quality in lighting is very much the concern of architects at present, and that it is in no way synonymous with more light. In many of the installations shown and particularly in the chapel at Otaniemi in Finland, and in the excellent slides of Gloucester Cathedral shown by Mr. Waldram, more light would almost certainly have resulted in less quality.

I think it may help towards an appreciation of the architect's approach to the lighting problem to distinguish between the lighting function and the architectural function. The lighting function is concerned with adequate illumination levels, correct geometry and direction of sources, the choice of light source and the absence of glare, whereas the architectural function is concerned with all the related architectural design factors such as economics, other services, spacial planning and appearance; appearance not only of the fittings themselves but of the lit effect of the whole which takes into account scale, proportion and, most important of all, unity. This is not to suggest that the lighting engineer should be concerned only with the former and the architect only with the latter, but it may explain why quality means one thing to an engineer and another to the architect.

Finally, I should like to ask one question. The paper states: "... imitations of daylight are to be condemned ... because straight imitation of daylight would deny artificial light the development of its own expression." Dr. Ballin showed photographs of the factory at Brynmawr where the artificial light and daylight enter from similar openings made in the roof to ensure the same light distribution for the factory process. In America, the Finnish architect Alvar Aalto placed light sources outside the roof of his M.I.T. dormitory common room with the light shining through the daylight openings. Do the authors suggest that this is necessarily wrong?

Mr. F. WIDNALL: Early in the paper the authors say, "The emotional reaction arises from a space sense that is not entirely visual. One can walk from a small low space into a large high space with eyes closed and, aural effect apart, there are other effects which tell unmistakably of the change." I would like to know what those other effects are, for I have tried an experiment in a completely blacked-out place. Apart from the sense of touch you can only get some idea of space by shouting or speaking and checking the echo.

In regard to the statement that "Generally, there is only one lighting scheme which will fit a given interior...," I think that requires enlarging somewhat, for there are many rooms and spaces which have more than one function and it can give rise to difficulties in planning just one lighting scheme. This I think also leads to the integration of lighting with the building, in which case I would ask for the assistance of the architect, for one of the greatest limitations in most fittings in comparatively older buildings is the lack of flexibility in the electricity supply system and in the construction of the building itself which does tend to fix the position of a rather limited number of lighting points.

On the question of the role of the illuminating engineer and the architect, I rather deplore the

effort or the desire to create a definite dividing line. I think the dividing line must necessarily be very flexible because it depends on the persons concerned. If the architect has a good appreciation of lighting I would say that generally he doesn't need a lighting engineer, but at the risk of horrifying the architect I would say that equally if a lighting engineer has a good appreciation of architecture he does not always need the architect.

Mr. H. E. BELLCHAMBERS : Mr. Baines has pointed out the importance of controlling shadow patterns and yesterday, in the paper on lighting in Finland, we saw examples of school lighting where asymmetrical specular reflectors were used to control light distribution and glare. In one example there was a distinct shadow pattern at the junction of wall and ceiling. The lighting fitting was doing what it was intended to do, but I found the shadow pattern rather disturbing. It should not be too difficult to soften those shadows but in doing this the cost of the installation would be increased. I feel that the architect can help very much here, for there is a third person who is interested in the design, and that is the client. He it is who finally decides on costs.

Another matter which has been discussed at earlier meetings is a need for flexibility in lighting schemes. The authors have mentioned the need to control shadow patterns, to clearly define shapes, and to maintain a well-balanced interior. I would like to know what the authors think about flexibility which might destroy the balance and shapes of an interior.

General diffuse lighting schemes are frequently introduced into buildings and result in a complete lack of character in the interior. Often it is because of a lack of appreciation on the part of the lighting engineer, but it is also a question of cost. Control of light by louvres, reflectors and diffusers will generally introduce additional cost and a scheme is easily ruined because refinement is not permissible.

The authors have suggested that the illuminating engineer could give the architects a great deal of help in the understanding of the effect of inter-reflection, but its effects can easily be seen with the help of a model.

Another suggestion made by the authors is one which my colleagues and I put forward in a paper given to the I.E.S. last year ; that is, the architect should draw up a specification of his requirements for the lighting engineer. That would be a good step forward in the collaboration between engineer and architect.

Mr. L. C. RETTIG : May I make a plea for monotony in some lighting installations ?—somewhere where one can withdraw from the architect's impression of stimulus. We are battered by advertisements and there are times when we wish to withdraw and even indulge in the luxury of thinking. There are areas required where this can be done with a certain amount of relaxation.

Dr. J. N. ALDINGTON : The authors have indulged in a certain amount of poetic licence this morning. It seems to me that to some extent Mr. Baines' comments have been coloured by the visual impression produced by the projection of a number of excellent colour slides. Whether or not these colour slides were really representative of the lighting effects on architecture on which Mr. Baines based his paper I suggest is somewhat questionable. We know from the work of members of this Society how difficult it is to produce photographs which truly represent visual impressions at the actual scene of the photograph. Although I am quite sure that Mr. Baines and his co-author are aware that they have indulged in the poetic licence I have mentioned I thought I would draw attention to the point for the record.

Mr. D. W. DURRANT : It is natural that in all professions there are a few brilliant leaders, but the majority are more prosaic. At a conference like this it is helpful to consider the work of such leaders, but I have also heard architects in general somewhat unkindly described as co-ordinators of building materials. As several of the installations to which the authors applied critical comment were designed by architects, I am prompted to ask whether or not the authors think that architects in general make good interior decorators ?

Mr. A. L. HOGG (in reply) : The first point I would like to make is in regard to collaboration. The most important part is the client's requirements. They must be most specific. Having got the client's requirements this may well determine the form of structure and the pattern of the lighting installation. The next thing is to determine the position for the incoming supply. This should be in the centre, and near the outside of the building for reasonable access in case of emergency. Having determined the position of the supply, provision has to be made to get the supply to the distribution points. In multi-storied buildings provision has to be made to get the service from one floor to another. What the architect often overlooks is the provision of means for the wiring to be done. You find pre-stressed

concrete beams, with the result that wire has to be exposed on the beam when lighting the room. Provision must be made for the cabling.

In the early stages the illuminating engineer must be given the costs allowed for his scheme, to enable him to determine how far he can go. It does mean that in the very early stages, even before the scheme goes on the drawing board, the engineer must not only collaborate with the architect but also with the client.

Mr. G. GRENFELL BAINES (in reply): This technique of collaboration does need developing. We find in practice that the best way of making it work is to have an engineer in the firm. But this is full of snags, and we still have to discover the advantages and disadvantages. Consultants can be very good, but they're often elusive and we have discovered that we must have a link man. We do not want to make an empire of a practice —or pretend to be electrical engineers, but we do find we need an illuminating engineer.

Mr. Hogg mentioned the difficulty in getting through beams and ceilings and the problem of getting through walls. Arising out of that difficulty we have evolved a structure where the beams fall *between* the columns. The service can therefore be brought up, avoiding the floor. To avoid overwhelmingly big lintels the columns are closely spaced like the mullions of the first Elizabethan era, but being concrete we can place them a little more apart. Thus we have adjusted our construction and whole architectural expression. Our engineer couldn't do all our electrical work, and so to some extent, but not completely, we are attracted to the commercial firms who offer a complete commercial service, we being in control of the basic design.

Education could help greatly in collaboration. You won't get collaboration between graduate people unless in their early days they have had contact with the subject in a way which leads to further development later on. Here we have to get down to principles and go to schools where engineer and architect can see those things that influence our work. Both professions can regard this as an investment—both professions depend on the student.

To Mr. Hewitt I would say that I must use some jargon, but I agree that the jargon must be pruned. As for " plastic integrity " it could be said to be a form which expresses itself clearly. I agree that we should not struggle too hard to confine relativities; education will help to remove the boundaries.

Mr. Widnall asked what were the effects that enabled you to tell the difference when going from a high room to a low room in blacked-out spaces. I have tried walking in spaces of different dimensions with my eyes closed to see what happened. Something in us, outside of hearing, makes us apprehensive of or perceptive of the nearness or farness of enclosing surfaces. We may not have found a way of measuring it, but we cannot rule it out. There is something about the nearness or farness of solid surfaces to which the human being responds; the reaction is not merely visual or aural.

Dr. Aldington spoke of the limitations of photographs, and I agree that they have their limitations. They don't always show what the eye sees, but in my view they show 90 per cent of it and in the absence of other devices they are the only means of expressing light and shade. Until someone finds something better I can only apologise for the inadequacy of the photographs.

" Do architects make good interior decorators ? " asked Mr. Durrant. Often, though not always. There can be something subtle about decoration which does not come exactly within the architect's province.

Mr. Rettig made a nice plea for a bit more monotony, but what he was really asking for was more variety. The answer is a proper balance. We do need changes of atmosphere, but I have yet to be convinced that complete evenness and dullness would stimulate anyone.

Mr. Phillips asked what I thought of the Aalto scheme which placed the lights *outside*. Well Aalto is a master and who am I to comment, except to note in passing that evidently the great man had noticed the same thing that I mentioned in my paper, namely the fundamental difference in the source position of natural and artificial light —outside or inside the space to be lighted. I feel that the right place for an artificial light source is *inside* the space to be lighted. There it can be more cheaply installed and maintained. Properly designed I do not see why a scheme of lighting with the sources *inside* should not be just as effectively expressive of form and surface as the daylight effect; indeed, if you regard the building as a musical score, daylight is one interpretation and " night light " another, to make one follow the other in such a fundamental matter as the position of the light source is to deny the chance of a true expression and a fresh interpretation. If this implies a criticism of the great architect then I must admit the presumption.

Finally, I think collaboration depends on wanting the same thing; that does mean sharing our sovereignty and interests in the general concern.

UDC 621.329

Design and Production of Glassware for Lighting

By D. SHELLSHEAR, M.S.I.A., and C. D. CARTWRIGHT, B.Sc.

Summary

The paper commences with a brief history of glass and glassmaking. It then deals with present-day equipment and the production of blown glassware for lighting. A description is given of the methods used to provide decoration either in or on the blown glass. Packing and transport are discussed. The remainder of the paper is concerned with the design of glassware and its association with light sources. Present-day designs in Britain, U.S.A. and on the Continent are discussed, and the conclusion deals with some future possibilities.

(1) Introduction

Dr. Johnson once said ([1]) " Who, when he first saw the sand or ashes, by a casual intenseness of heat melted into a metalline form, rugged with excrescences and clouded with impurities, would have imagined that in this shapeless lump lay concealed so many conveniences of life as would, in time, constitute a great part of the happiness of the world ? Thus was the first artificer in glass employed, though without his knowledge or expectation. He was facilitating and prolonging the enjoyment of light, enlarging the avenues of science, and conferring the highest and most lasting pleasures."

This paper is not concerned with the more complex aspects of lighting but will concentrate on the design and production of blown glass, in which appearance and craftsmanship are of such vital importance.

(2) History

(2.1) Glassmaking

Traces of opaque and coloured glass have been found in Egypt and are thought to date back to about 5500 B.C., though more definite references can be traced to about 1400 B.C. Blown glass was probably first made at Sidon in 300 B.C., at about the time of Alexander.([2]) In Roman times the glass industry expanded rapidly and at an early date, in Lorraine and the German States, cylinders were blown, cut open and flattened to form sheets. The blowing technique was also used in Normandy in A.D. 1330 to provide a sphere of glass which was transformed, by various means, into a flat disc. This was spun when hot, and enlarged into a circle of " crown glass " from which window glass was cut.

Glassmaking in England, apart from Roman times, really started about 1200. In 1615 Sir Robert Mansell obtained a patent to burn sea coal and granted licences to foreign workers, and by 1696 there were about ninety glasshouses in England and Wales.([3])

(2.2) Early applications

With the earliest light sources, such as oil, rush lights and candles, very little use was made of glass, either to protect the source, or as decoration. One of the earliest records of the use of blown glass is the lacemaker's condenser—a water-filled spherical bottle suspended a few inches from the flame of a candle.

In 1784 the Argand oil-lamp, with a glass chimney, was developed. This chimney had functional uses in protecting the flame and assisting combustion and it proved to be the beginning of the use of blown glass in lighting. Gas lighting commenced at the end of the 18th century and expanded rapidly when Welsbach patented his famous mantle in 1893. A glass chimney was again used to protect the mantle and to assist combustion.

The use of the electric lamp developed rapidly after the squirted cellulose carbon filament was perfected in 1893, and the era of the modern lamp began with the process for making ductile tungsten in 1909.

(2.3) Crystal glass

The use of lead or crystal glass enabled the crystal chandelier to be developed. In 1771 crystal chandeliers were installed in the Assembly Rooms at Bath and these are the finest surviving examples of the 18th-century glass-maker's art.([4])

Crystal chandeliers were used a great deal for large private houses, palaces and public buildings, but as they relied on the brilliance of the candle source, the introduction of the gas flame and mantle made chandeliers unfashionable ; yet the

Mr. Shellshear is with Troughton & Young (Lighting) Ltd. and Mr. Cartwright is with Stevens and Williams Ltd. The manuscript of this paper was first received on February 11, 1958, and in final form on March 19, 1958. The paper was presented at a meeting of the Society at Eastbourne on May 12, 1958.

skill in manufacture was applied later to blown glass.

(2.4) Blown glass

The development of the three types of light sources, oil, gas and electricity, overlapped and glasses developed progressively together with little delay between the changes in design and decoration.

Very little evidence can be found of any large-scale production of lighting glass in Britain about the end of the 19th century; in fact, about this time large quantities were being imported from the Continent, and these were intended for all three types of light sources. The glass chimney for the oil lamp was, and still is, a functional part of the lighting unit, but solid opal glass hemispherical shapes began to appear, supported around the glass chimney, and these developed with mould decoration and ceramic enamels. Meanwhile, glasses for the gas industry appeared. Here again, the need for diffusion became necessary and many shapes and types of decoration were available.

Glasses for use with the electric lamp started amid the development of the gas industry but these glasses made more use of treated clear glass. Though three-ply or cased opal was being imported before 1914, no large-scale production of this kind of glass occurred in Britain until after 1918, when the lighting glass industry in Britain really started. The decision of British manufacturers to enter this field was probably influenced by the scarcity of imported blown glass, and their desire to compete with Continental manufacturers.

(3) Manufacture

(3.1) General

It is necessary to go back in history to indicate one or two interesting facts about the manufacture of glass. The raw materials for ordinary glass, the methods and the utensils used, have varied very little over the years, but there have been changes in the furnaces which melt the glass.

The first organised glassworks consisted of a number of "pots" or containers, made of clay, grouped together. The raw materials were melted in these pots and the glassworker drew his molten glass from an opening in the top. Pots are still used to-day, but owing to the heavy demand for the basic clear glass the continuous tank was introduced. In this type of tank, as its name implies, raw materials are fed in at one end and the glass is continually melted and worked out at the other end. The first fuel to be used was wood, which was replaced successively by coal and gas, and to-day oil-fired burners are being extensively used, supplemented when necessary by electrical elements at various points. The latest development is the melting of glass by electricity alone.

After blowing, the glass has to be annealed to avoid all stresses and strains that might be set up during cooling. Originally this was done by placing the glasses in ovens, but today the continuous belt system through a "Lehr" is employed. Clear glass for the lighting industry is mostly made by mixing sand, soda ash, limespar, nitrate of soda, borax and arsenic. This is called "soda-lime flint" glass and is normally melted at a temperature of 1,400 deg. C. in the continuous process tank. It then passes to a second chamber, where it is allowed to cool to about 1,100 deg. C. ready for working (Fig. 1). Coloured glasses, which are usually required in relatively small quantities, are melted in individual pots set round a furnace and the coloured glass taken off as required. The basic ingredients are similar to the clear glass with certain additions, a few examples being:—Sodium silico—fluoride to produce opal, selenium to produce pink and ruby, uranium to produce

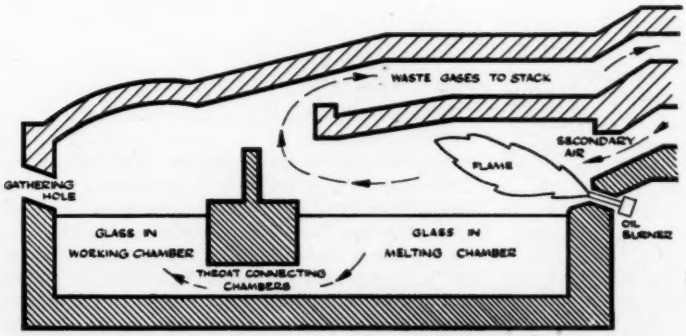


Fig. 1. Diagrammatic drawing of a continuous tank showing the two chambers, the source of heat and the gathering hole.

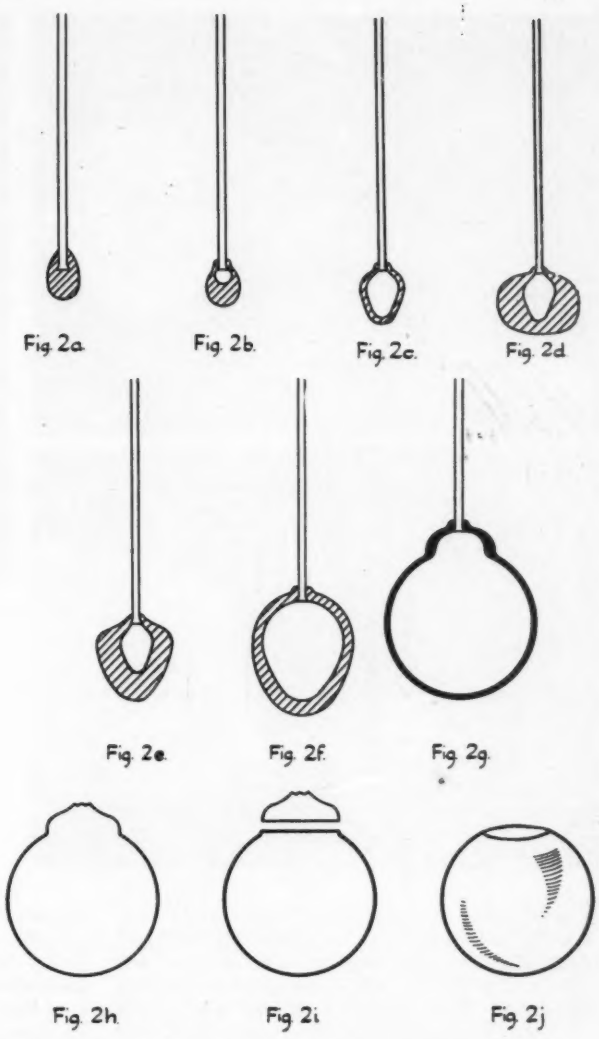


Fig. 2. Diagrams of the various stages in production. Figs. 2a-g show the operations during blowing. Figs. 2h-j show the subsequent operations.

champagne, cobalt to produce blue, potassium bichromate to produce green, lead oxide to produce lead crystal.

Heat-resisting glass is made from similar materials but with more sand and borax and much less alkali than ordinary soda-lime glass to give a lower thermal expansion coefficient and, therefore, a higher thermal endurance, and it has to be melted at a higher temperature.

To describe the actual blowing, consider the simple example of the lipless sphere. The glass-worker, having his molten glass ready to hand picks up his blowing iron, which is a hollow metal tube with a mouthpiece, and " gathers " on to it some molten glass. The first " gather " is quite small for ease of manipulation (Fig. 2a). This is then shaped and evenly distributed round the end of the blowing iron by rolling it to and fro on a flat steel surface and revolving the molten glass in small hollowed-out wooden blocks. A small bubble is then blown inside this first "gather" of the glass (Fig. 2b) and with further shaping this

Fig. 3 (top left). The actual blowing operation and completed glass ready to be cracked off.

Fig. 4 (above). The glass receiving its final shaping in a mould.

Fig. 5 (right). The glasses, after blowing and cracking off, being put into the "lehr" for annealing.

is enlarged by blowing until a hollow ball of glass about 3" in diameter is obtained (Fig. 2c—see also Fig. 3). After being allowed to cool until rigid, this forms the basic structure for subsequent operations. The ultimate weight of molten glass required is then gathered on to the original ball by dipping into the tank or pot (Fig. 2d) and is evenly distributed with large hollowed-out wooden blocks (Fig. 2e). The glass is then gradually blown out by the mouth and shaped until it is approaching its final design both in shape and size (Fig. 2f). After being lowered vertically into a finishing mould, the glass is blown out until it takes up the shape of the mould and has cooled sufficiently to become rigid (Fig. 4). The mould is opened up and the completed blown glass is lifted out (Fig. 2g). The whole process takes about four to five minutes, depending on the size of the glass, and is accompanied by a supple and expert manipulation of the various tools. The blown article is knocked off the blow iron on to an asbestos fork and is quickly transferred to an annealing "Lehr" or oven (Fig. 5) where it is reheated to about 550 deg. C. It travels slowly through on a continuous belt until it comes out at the other end after approximately three hours, during which time the temperature of the glass has been slowly and uniformly reduced to room temperature (Fig. 2h). This process ensures that the inner and outer surfaces of the glass cool at the same rate, thus preventing any strain or stress which would cause the glass to fracture.

Any unwanted portions of the glass are now removed by placing it on a revolving stand whilst a small gas flame, at the required height, plays along the line on which the cut is required. This

produces a hot band and when this is touched with a cold steel, the glass parts cleanly (Fig. 2i).

The removal of the unwanted glass provides an excellent opportunity for inspection, for now a lighted lamp can be inserted and the quality and transmission can be examined. The cutting-off procedure leaves the article with a razor edge which is removed on an automatic grinding machine, or by a hand-grinding process using a mild steel revolving mill or wheel with either sand or carborundum grit as a grinding medium (Fig. 2j). From this stage the glass goes through a final inspection and cleaning, and then to the packing bay for despatch or storage.

A large part of the output of blown glass for the lighting industry is in cased or three-ply opal. Here the original ball of clear soda-lime glass is dipped into opal glass before making the final gather of clear soda-lime glass and the procedure, as just described, is then followed to its conclusion. It is on this mixture of clear and opal that the relative co-efficients of expansion of the two glasses must be carefully controlled to avoid any stress or strain. Every morning sample rings of flint and opal are made and deliberately cracked to see that the expansion ratio is correct.

(3.2) Variations of blowing methods

The manufacture of coloured flashed opal glass is carried out in the same way except that, instead of clear glass, the coloured variety is used with the white opal. With the aid of coloured glass it is possible to obtain rich primary colours or pastel shades.

There are many methods of incorporating diffusion or decorative effects during the blowing operations. To produce a " Flakestone " effect, coloured glass chippings can be picked up on the initial ball. These melt, and after the second gather are " cased " between the two clear " flint " layers. In a similar way the initial gather can be dabbed or streaked with small amounts of colours from heated glass rods to produce spots or veins. An interesting technique is the picking up and twisting of coloured glass rods, which become embedded for the full length of the glass and produce a most interesting pattern. It is also possible to use a mould which gives a pattern on the glass, the pattern appearing in a modified form on the final article.

(3.3) Moulds

These are provided as a final aid to the glassblower's craftsmanship. Moulds have changed little over the years except that they are now made with much greater precision. The vast majority of them are in two or more pieces and are made of cast iron, machined on the inside to the required shape of the glass, leaving an opening in the top. Reverting to Figs. 2a–2j, the mould for this sphere is a simple example of a mould made in two halves with a vertical joint. To provide a form of lubrication inside the mould, a carbon deposit is left on the inside by burning paper or thin strips of wood. During the blowing process, the joint mark in the mould transfers itself to the glass, but when the shape is one that can be turned by rotating the glass inside the mould, the mark is removed. There are, of course, many types of blown glass which cannot be made in a mould in which the glass turns, e.g. a cube glass or circular glass with a screw thread. In the latter case the mould incorporates a collar with the screw thread, but as the glass cannot be turned, a slight mould mark appears on the outside of the glass. This type of mould also requires heating during the blowing operation.

(3.4) Other types of manufactured glass

Bent glass is made from sheet and plate, either plain or with some pattern on the surface made in the rolling or casting of the glass. It can be bent in the form of a trough or in the shape of a saucer or dish by heating the flat piece until it collapses into a mould of the required shape.

Pressed glass, used in the lighting field usually for the prismatic control of light, has been dealt with adequately in other papers presented before this Society[5]. It is made by dropping molten glass in a mould and applying strong pressure on a plunger to form the glass article.

(3.5) Craftsmanship

It will be seen from the foregoing that the manufacture of blown glass relies very largely on the skill of the craftsman from start to finish. An error at any stage can result in serious loss of production and raw materials. The tools and moulds are all an aid to assist the glassblower, but the work calls for accurate judgment of the correct mixture, temperature, size, weight, colour and shape.

(4) Decoration

(4.1) Treatment on the glass

A limited amount of engraving, cutting, sand-blasting, etching, and embossing is still done, perhaps more on the Continent than in Britain, but it is generally confined to simple lines and masked work to provide the artistic result in an economic way.

Brilliant cutting on a wheel with acid polishing

is usually employed with lead crystal glass for the best results. Coloured cased opal or three-ply opal can be treated in a similar way by cutting through the opal layer, but this must be done from the inside otherwise the glass would be cut right through. It must be polished by hand, as the process used on the crystal glass cannot be applied to soda-lime glass.

A large amount of general sandblasting is done on a clear glass to provide the necessary diffusion, and there is also the satin etch surface which is usually applied to a cased or three-ply opal glass by dipping it into a bath of acid.

(4.2) Decoration applied to the glass

The simplest way to apply decoration is to spray with a form of coloured lacquer, but although this finish is economic, it is not very durable. Permanent decoration has always been achieved by the application of ceramic enamels. These are being used more and more, and they undoubtedly present the greatest scope.

The ceramic is sprayed on to the surface, which may be masked or not according to the required design. After drying, part of the surface can be removed by means of a scraping instrument, and the ceramic is fired on the surface of the glass.

One type of ceramic decoration is " Sparkelite " or " Crinkle," which comprises very fine powdered glass, clear or coloured, sprinkled by hand on to an adhesive sprayed on to the clear glass. The article is then fired in the same way. Ceramic decoration has one disadvantage : it is not possible to provide deep rich primary colours which would compare with the quality of transmission of natural coloured glass.

Applied decoration also includes mirror finishes, where the glass is coated with silver nitrate to give a reflecting surface.

(5) Packing and Transport

This is one of the most serious problems facing the lighting glass industry in this country. The ideal solution is to wrap a clean glass in paper, protect it with dry packing in a cardboard carton and pack a suitable number of glasses in a robust case. Unfortunately, the wide range of sizes and shapes, and the high cost of the packing materials and transport, make it impossible to meet this ideal, and the manufacturers compromise by packing the glasses with straw in crates, which are then at the mercy of the elements during transport and storage. This method is not satisfactory, as the first sight of a particularly attractive glass can be spoilt by its dirty appearance. Furthermore, considerable trouble and cost are involved in returning empty crates.

Continental firms, on the other hand, export glass individually packed in cartons. There is a move in this country to wrap glasses individually in corrugated paper and to send them out in non-returnable cartons. A great deal could also be done on similar lines to reduce packing charges on glasses exported from this country.

(6) Design

(6.1) Development

As early as 1913 an article was written pointing out some recommendations for the design of glasses for the " new " electric lamp, (*a*) to tone down the excessive brilliance of an illuminant, (*b*) to direct the light where it is chiefly needed, (*c*) to soften the shadows, (*d*) to serve as a decorative object.[6]

The basic principles of design for lighting glass must include these four recommendations and must also allow for a careful relationship between the shape of the glass and the source of light, an appreciation of heat problems, assembly of the glass and associated components, ease of production and of maintenance, and reasonable cost. The old phrase " fitness for purpose " allied with a pleasing appearance sums this up very well.

There was very little production of lighting glass in this country before 1914 and consequently no real design work was necessary as the glasses were imported from the Continent. After 1920 several British glassworks started, but initially they were trying to compete with the Continental imports. Though flashed opal glass was now being made in this country, most of the fittings produced between 1918 and 1925 were " period " designs, and it was the Paris Exhibition of 1925 which must be held responsible for the introduction of fittings based on the box shape and also fittings with angular glass panels set into clips. Even in Germany similar angular forms had a period of ascendancy about 1922. Walter Gropius, the distinguished German architect and designer, created the " Bauhaus " in 1919. This was, perhaps, the first school of industrial design and it was able to prepare and sell new ideas. This German school brought out some designs for simple spherical shapes in 1923, and these were developed on the Continent and were imported into this country, followed by box type, tubular and multi-light spherical fittings.

There is a possible reason for the apparent lack of progressive design at this time. In the 1930's apart from one or two isolated cases, it was entirely due to the lack of experienced designers.

The designs which were being produced, though they sold well and satisfied public demand, were the product of a draughtsman putting on paper a sales requirement; or possibly a basically sound engineering design was taken over by an artist who then applied " decoration " which covered up the simple and clean shape produced by the engineer.

In this country in the late 1920's some enclosed shapes in flashed opal glasses with lips and 3-screw fixings were made and sold in large quantities for office use. In design, however, they did not compete very well with the spherical range of fittings which had by now been enlarged to include glasses with screwnecks. Another development about this time was the cube of Continental origin, an example of the skill of the glassblower being mis-directed to produce an unsympathetic shape. Though " Flakestone " bowls and hand-painted decorative glasses were available between the two wars, little attempt had been made to introduce design into domestic fittings.

In the late 1930's the pure functionalism of the sphere, though still steadily increasing in popularity, was being supplemented by more severe drum shapes which later were fitted with " halos " of glass. This was probably derived from the Scandinavian countries where the " Saturn " type of fitting had been popularised, but it has been claimed that the halo fitting was a British development. Just before the outbreak of the 1939 war, several companies in this country were beginning to realise that pure functionalism was not enough, and fittings with a decorative appeal began to appear with interesting developments in patented metal attachments (Fig. 6).

(6.2) Post-war design

This period has seen, without doubt, the most interesting developments in the history of lighting. Lamps and fittings have progressed at a much greater rate, and this is very noticeable when present-day blown glasses are compared with those of the 1930's. There was, of course, an inevitable lag of a few years immediately after 1945 whilst manufacturers were reorganising and coping with the initial shortages of manpower and materials which were reflected in many forms of control and rationing; also, fluorescent fittings had priority for development in some cases. Though open base glasses had appeared in small quantities before the war, it was not until the late 1940's that a serious demand was felt. This demand created the now familiar " acorn " open base glass.

(6.3) Post-war government action and professional interest

The Council of Industrial Design was formed in 1944 and gave a lead to all manufacturers and designers by an insistence on certain standards of design. The Society of Industrial Artists is a professional society for designers in all fields of industry. It was formed in 1931, but has only really developed in post-war years. Various exhibitions were held in these years which have had an effect on designers and on the public. The most important of these were the " Britain Can Make It " Exhibition in 1946 and the " Festival of Britain " in 1951. The former was successful from the designer's point of view but rather " passed over the heads " of the general public. On the other hand, the latter was an outstanding achievement, the designer again showing his imagination whilst the wider public became aware of good design for the first time.

Fig. 6. A 1938 fitting with an open base and with special consideration given to the internal metal attachments.

Whilst on the one hand the Government were trying to sponsor good design, on the other hand they imposed a severe restriction by the ban on the use of brass and copper for many purposes between February 1951 and December 1952. These difficulties were so great that they held back the development of blown glass fittings.

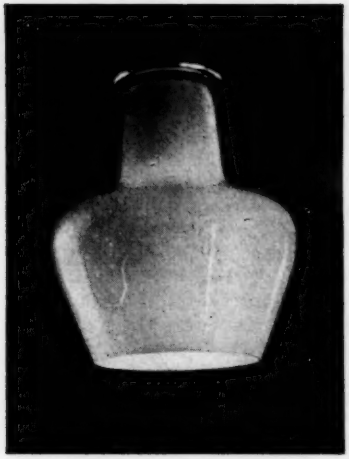


Fig. 7. A post-war fitting of 1953 with open base and a pleasing shape.

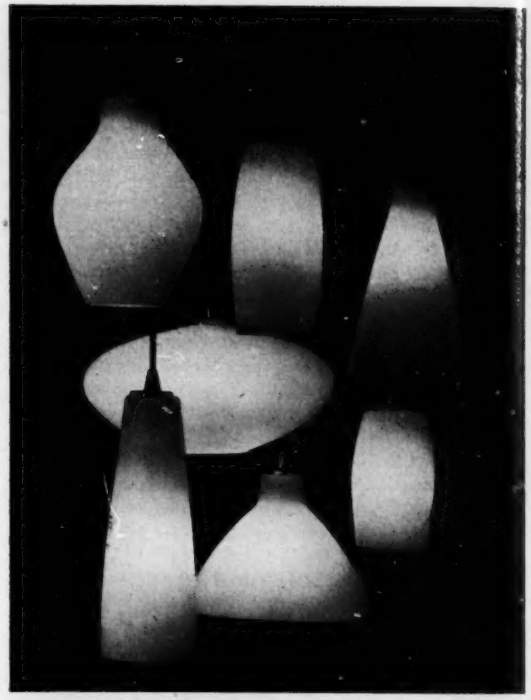


Fig. 8. Seven British-designed satin etched flashed opal glasses, imported in 1955.

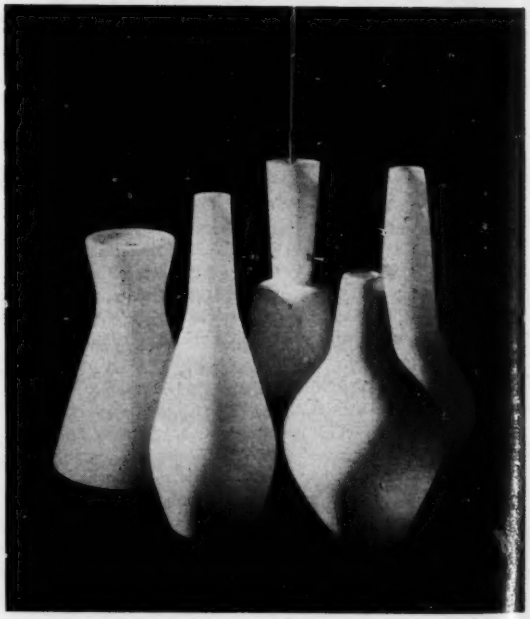


Fig. 9. A range of glasses imported from Sweden.

(6.4) Modern design

(6.4.1.) *Design in Britain up to* 1955

The Festival of Britain did not produce much in the way of new designs in blown glass, but rather exhibited the use of metal in various interesting shapes and forms. More companies became interested in the need for design, but generally they adopted a cautious attitude and, with the influence of the Festival of Britain, embarked on the design and manufacture of fittings which could be made and controlled directly in a factory with the minimum of tooling and outlay of capital. Costs of all materials and labour were steadily rising and confidence in the ability to sell new designs profitably had not been sufficiently established to spend capital. With the success of these new ranges, mainly based on metal, the designer's place became firmly established. Though new blown glasses were being made, these were mainly further developments from other designs and a new appreciation of blown glass had not yet been reached. About 1953 more interesting shapes appeared and were used in a more imaginative way (Fig. 7). The open base principle was here to stay and examples occurred of metalwork specially designed to suit this principle. Multi-light fittings were available in 1948 and thereafter they began to appear with interesting glass shapes, which led to a vast improvement in the types used for important buildings.

Since the war, it had been realised that it was not always possible to make and sell a glass and its metal attachment as one individual fitting, and the manufacture of component parts, each with many uses, became standard practice. This presented more problems for designers as it was necessary to design for a much larger range and more foresight was needed if each component was to be successful in all its applications. After 1953 other new ranges appeared and these gave evidence of a more enlightened approach to the glass problem ; glasses became smaller and their versatility greater. Design was improving with a greater appreciation of the glassmaker's art (Fig. 8).

(6.4.2.) *Design overseas*

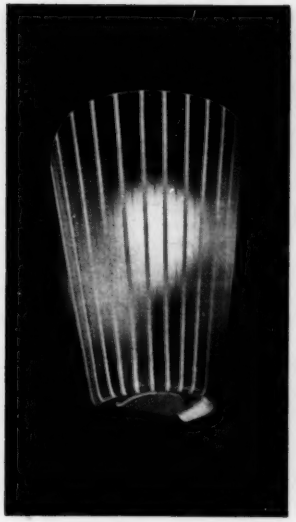
Progress in Sweden during the war was not so retarded as in other Continental countries and it is quite possible that Sweden played a large part in influencing Germany and Britain towards better design. Blown glass for lighting did not develop in Sweden until the early 1950's and one designer employed by a glassworks produced an outstanding range which was based on long shapes instead of the bulbous ones hitherto associated with blown glass. Not only were these shapes pleasing, but the decoration was part of the design, and the glasses had a satin etch surface which added to the overall elegance (Fig. 9). The metal parts associated with these glasses also had some interesting features. These glasses were imported into this country late in 1954 and proved to be very popular.

In Germany the necessary re-organisation of industry provided the spur needed to improve design, and the designer's place was firmly established. One eminent designer was employed to design lighting glass and the results appeared in 1954. These designs were so successful that firms outside Germany became interested and several types of glass were imported into this country (Fig. 10). These glasses, and subsequent ones, demonstrated effectively the use of blown glass as a designer's medium (Fig. 11). Decoration by means of mould applications and also by ceramic designs after blowing, were integrated into new and interesting shapes.

In Germany the lighting industry is much bigger than in this country. The general public are more lighting conscious and much more interest is taken in domestic fittings, acceptable designs being seen in nearly every home. It is not suggested, however, that all German fittings are of good design, but there is no doubt that the overall standard is much higher than here, though the gap is steadily narrowing. As the demand is much higher, the glassworks can afford to employ a research designer and market fittings of better design, even though they are not being used very much domestically.

The Hanover Fair in 1956 provided a great international spur to the design of blown glass. In July 1956, Design Magazine presented an article about foreign and English blown lighting glass which indicated that a lot of foreign glass was being imported. It suggested that more co-operation could take place between the British glassworks and designers to compete with this foreign influence. This challenge is now being accepted but foreign firms have a good start.

In the United States of America a similar trend in the design of blown glass has now developed. The latest designs have gained considerable popularity, and employ the sympathetic use of blown glass with decoration either in or on the glass, as in this country. In addition there has been a large increase in the use of bent glass, and recent designs have again achieved a good standard, all the traditional applied decoration being avoided (Fig. 12).



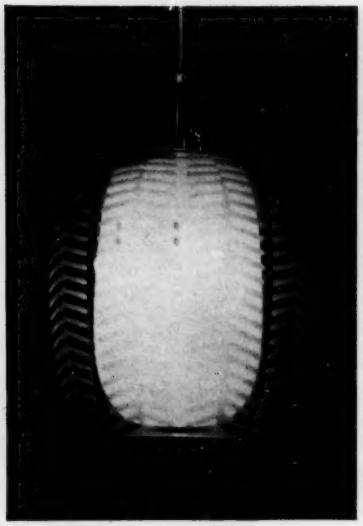


Fig. 10 (Left). A glass imported from Germany showing the delicate decoration and elegant shape. Fig. 11 (Centre). A well-designed German fitting with a double glass, the outer one clear except for a delicate sandblasted design. Fig.12 (Right). An American fitting of 1957 using a bent glass with a corrugated surface.

Glasses designed and made in Germany are being imported into the U.S.A. and are undoubtedly providing a strong influence. In addition, U.S.A. designs are being made in Italy, where the appreciation of the skill of the glass-blower is very evident and certain of the mass-produced lighting glasses are of first class design. There is also a great deal of outstanding work done by the production of small quantities of exclusive glass shapes incorporating many techniques known to the blown glass industry but not considered economic for mass production. Recent examples show various coloured glasses " gathered " during the blowing and producing an interesting effect. Many of these exclusive designs are exported to all parts of the world.

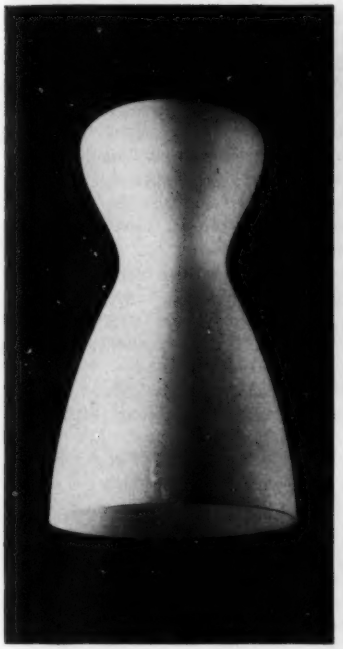
(6.4.3.) *Design in Britain from* 1955 *to present day*

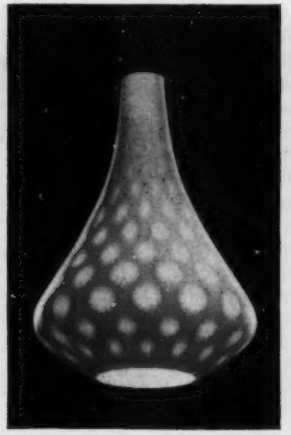
With the Continental influence several new ranges have been introduced in this country. As a direct outcome of the criticism of the use of foreign glass a range has been designed in white and pink flashed opal glass with satin finish, but without any mould or applied decoration, and for individual and collective use (Fig. 13). In addition there are some flashed opal glasses in deep colours, red, yellow and green. The use of coloured flashed opal, whether a deep or pastel colour, is not likely to progress unless the industry as a whole co-operates, as otherwise it would be uneconomical.

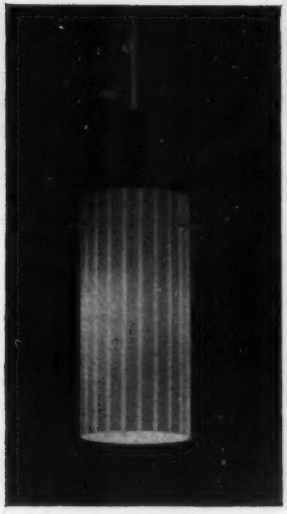
Other ranges are being manufactured in which there are interesting shapes with decoration as part of the design, produced from the mould or by application. Mould decoration is provided either by surface indentation of the glass or by picking up coloured rods during the blowing, whilst the applied decoration uses ceramic enamels either masked or cut away. These new ranges are using colour to a much greater extent and designers in this country are leaning more and more towards the use of colour, mould techniques and applied decoration (Figs. 14, 15, 16 and 17).

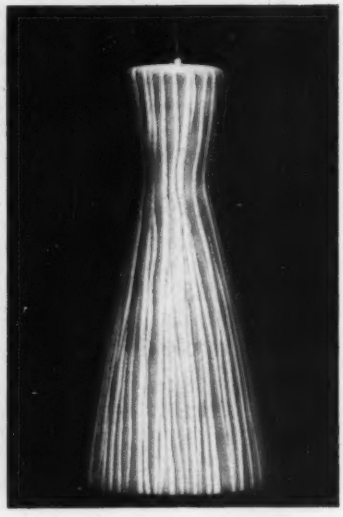
(7) Future Possibilities

There is no doubt that glass as a medium will never die out ; it has withstood competition for thousands of years and will continue to do so. Present trends will probably develop by the use of new mould techniques and applied decoration. Design has a peculiar habit of turning full circle and it may well be that blown glasses of the future may revert to a highly decorated age, but with a relationship between decoration and design. It is certain that internationally the exchange of ideas will increase as idealogical, geographical, social and language barriers are broken down. Though national ideas will still









13 | 14 | 15
| 16 | 17

Fig. 13. A British made and designed blown glass, available in pink or white flashed opal with a satin etch surface.

Fig. 14. A blown glass with mould decoration in satin flashed opal, designed in Britain and made in Germany.

Fig. 15. A blown glass in flashed opal with a yellow ceramic pattern designed and made in Britain.

Fig. 16. A flashed opal cylinder with bold red, yellow or black ceramic stripes.

Fig. 17. A blown glass in flashed opal with an imaginative use of ceramic colour.

prevail more influence will be felt from outside sources. The proposed " free trade " scheme will, in the end, assist the breaking down of these barriers, but it is fairly certain that initially the lighting industry and the glass works in this country will have to withstand some fierce competition, both economically and in design.

It is suggested that the blown glass industry in this country should intensify their efforts to encourage good design, so that their association with the fittings designers will prosper. In this way, the skill of the craftsman will not be lost and the upward trend in design will be fostered. Thus the public will become more and more design conscious and this must ultimately be to the benefit of the blown glass industry.

(8) Conclusion

The authors would like to thank many manufacturers in the glass and lighting fittings industries, both in this country and abroad, for their assistance in providing information. They would also thank the Directors of Troughton and Young (Lighting) Ltd., and Stevens and Williams Ltd., for permission to publish this paper.

References

(1) Dodd, G., British Manufactures, Metals, etc., Series 4 (1845).
(2) Rogers & Beard, " 5,000 years of glass " (1937).
(3) McGrath, R., & Frost, A. C., Glass in Architecture and Decoration (1937).
(4) Elville, E. M., " English and Irish Cut Glass, 1750-1950 " (1953).
(5) Holmes, J. G., Trans. Illum. Eng. Soc. (London), **14**, 197 (1949).
(6) Gaster & Dow, " Modern Illuminants and Illuminating Engineering," (1915).

Discussion

Mr. B. Davis : There is something in this paper that interests me particularly and that is the set of four principles whereby the designer of glass for lighting has a guide. But these four principles date back to almost medieval days—to 1913 in fact. These were the only things in the paper that I found to quarrel with. I wonder whether these four principles are in fact still valid today.

The first is that the " brilliance of the illuminant should be toned down." This has been over-done. All these opal glasses which we have seen are charming articles but do they give that lifelike sparkle which satisfies the clients ?

Secondly, " direct the light where needed." This is one which I don't think is being carried out at all. The light is spread out everywhere, and we have a uniform illumination over a large area.

The third principle is " to soften shadows." This is really a repetition of the first two. Shadows provide a degree of contrast which rests the eyes, an effect which you cannot get nowadays by using glass fittings.

The last point is the use of the glass " to serve as a decorative object." Present-day designers are doing a magnificent job in this respect, and having seen the slides and the fittings themselves I think you will agree that we have never had more decorative fittings than we have today. But might we have a little more decorative quality in the lighting itself ? An attempt to meet the demand for sparkle is the fitting with little plastic stars a few inches from the light source.

Do the authors think there is any room for development by using a clear glass which will show, in addition to its own shape, some form of excitement in the light itself which is produced ?

Mr. D. R. H. Phillips : Until very recently the British glass industry appeared to suffer from a degree of inflexibility in its design and production methods, and designers of lighting fittings have been forced to go to Germany and Scandinavia for glass combining high quality with good design.

The article by John Blake in *Design* referred to by the authors did more than " suggest closer co-operation " ; it offered a challenge to the British glass industry and there is evidence that at least two glass manufacturers are making a real effort to meet the designers' needs in economic terms. The results are still on a comparatively small scale and I would like to ask the authors what proportion of the glassware used in the lighting industry is imported, and what is being done to increase the ratio of British glass.

The second point I want to note is what to me appears to be the primitive methods of glass manufacture illustrated in the film and photographs presented. The lighting used, where it appeared to exist at all, consisted of bare filament lamps and I should be interested to know whether these conditions are likely to stimulate efficiency or whether any German or Scandinavian manufacturer present could say whether production methods in their country resemble those shown.

Finally, I was disappointed that the paper was confined to technique and a review of available shapes and that no rationale of design was attempted. Many of the shapes shown seemed beautiful, and the more simple the more beautiful, but in many cases the applied decoration seemed out of sympathy with the shape. Surely decoration should only be used to enhance the beauty of

the form (when either lit or unlit) and not to distract from it ?

Mr. A. H. NASH : Can the authors tell us why the use of sand-blasting continues when the satin-opal method is readily available ? Sand-blasting is not convenient from a handling point of view, whilst the satin-opal method is satisfactory.

Mr. E. S. DUNCH : Could a glass be designed which does not need a large bulb to provide the necessary light ? With the opal glass you have to use a large bulb—are large glasses produced for smaller lamps ?

Mr. A. POTT : I regret that the word " design " is used in this paper in such a limited sense. It is virtually restricted to the appearance of the fittings ; their shape, colour and surface treatment. In short, the paper concentrates on the fourth requirement quoted from Gaster and Dow—" to serve as a decorative object "—and ignores the other three. These are equally important in any fitting which is to be used for other than a purely decorative purpose. No mention is made of distribution, surface brightness or other functional characteristics of the fittings. It confirms my opinion that the glassware makers are lagging in giving the purchaser information about their products.

Mr. D. SHELLSHEAR (in reply) : I think Mr. Davis's comments are quite justified, but I feel he has misunderstood the meaning of the recommendations laid down in 1913. " To tone down the excessive brilliance of the illuminant " was, in those days, meant to reduce the glare. Sparkle is another matter, and I entirely agree that this is of interest and more thought can be given to it on future designs, providing it does not become annoying and is made in an economic way, avoiding the intricate hand operations used in crystal glass table ware and chandeliers.

" Directing the light " was, I am sure, meant to provide light where it was required. Decorative lighting glass does not " direct " but our present designs have gone a long way from the utilitarian designs of the 1920's which only gave uniform illumination.

" Softening shadows " is, of course, related to the previous two recommendations but I feel it was meant to break down the hard shadows which were very common then, especially with the clear lamp. Shadows are of great interest but too much contrast can be disturbing.

" To serve as a decorative object " is the main issue as far as design is concerned and the introduction of " sparkle " to lighting glass is certainly another development which will receive a lot of thought.

Mr. Phillips asked for figures on lighting glass used in this country. This paper was not meant to present a direct comparison between imported and British glass, and these figures can be misleading as they represent *all* forms of lighting glass (excluding lamps).

Year	*Imports as a percentage of Home Sales*
1953	21
1954	36
1955	32
1956	31
1957	43

From this table it will be seen that for every £100 of British glass sold at home in 1953 an additional £21 of imported glass was also sold in Britain, and in 1957 the figures were £100 and £43. These figures show, therefore, that imports are getting a bigger percentage of the sales in this country.

This does not mean that the British manufacturer is falling behind. Designers in this country must redouble their efforts to produce better designs, they must travel more and widen their outlook, and with the help of the manufacturer there is no reason why we cannot improve the sales of British designed lighting glasses.

Applied decoration can be a trap but as I mentioned in my closing remarks we must be careful that applied decoration does not destroy a beautiful shape. With the experience and knowledge designers have gained over the last few years, and with the co-operation of the industry itself, I am sure we can overcome this problem.

In reply to Mr. Dunch, this question really relates to the transmission properties of the glass. White flashed opal has a very high overall efficiency and does not reduce by very much the actual lumen output of the lamp but, of course, design and applied decoration must be carefully considered to avoid too much reduction in efficiency.

Mr. Pott's question is really outside the scope of this paper ; we could not possibly have included the technical data. In fact, this could form the subject of a whole Summer Meeting. Functional characteristics are considered in design, not in terms of figures, but in the design as a whole.

Mr. C. D. CARTWRIGHT (in reply) : Mr. Phillips mentioned manufacture. The methods may appear to be a little primitive, but this is because no other means has yet been devised for blowing

the more complicated shapes. Mechanisation has been introduced in the form of pressing and also combined pressing and blowing with compressed air, but these processes can only be applied to articles of very limited shape and size and no machine has yet been invented which can emulate the skill of the glassblower which is necessary to produce the varied shapes required for modern fittings.

The film of the glassblowing process was purposely taken at dusk without any artificial lighting, so that the molten glass would stand out vividly against the dark background, thus concentrating the viewer's attention on the shaping, blocking and blowing-out processes, without being distracted by objects in the background. The bare filament lamps which appeared in the slides are there for a purpose. The articles are placed over these lamps for inspection purposes during the ancillary processes.

In reply to Mr. Nash, the satin finish aciding process gives an overall diffusing effect, but sand-blasting is a decorative application and is usually applied in conjunction with masks or templates so as to leave a frosted pattern on the glass.

Additions to the List of Members

The following applicants have been duly elected by the Council to membership of the Society :—

Sustaining Member

T. Beadle Export Co. Ltd., 8 Castle Street, Hull, Yorkshire.
Representative: W. R. Ashley.

Corporate Members

Aldworth, R. C.	58 Whitton Dene, Hounslow, Middlesex.
Baker, G. A.	Sangamo Weston Co. Ltd., 89 Victoria Street, Liverpool
Biderman, E.	48 Barbican Buildings, 89 President Street, Johannesburg, S. Africa.
Brown, R. E.	20 Haines Street, Battersea, S.W.8.
Clark, D.	Stoneybrook, Belmont Grove, Rawdon, Leeds.
Davies, P. M. A.	31 Cadleigh Gardens, Harborne, Birmingham, 17.
Deloire, M.	119 Rue de l'Eveche, Marseille, 2, France.
Dinning, R.	169 Westgate Road, Newcastle-on-Tyne.
Elder, H.	College of Architecture, Cornell University, Ithaca, New York, U.S.A.
Green, R. E.	41 Salcombe Road, Ashford, Middlesex.
Halifax, D. G. D.	274 Wickham Lane, Abbey Wood, London, S.E.2.
Lister, H.	39 Bradley Avenue, Winterbourne, Bristol.
Long, C. G.	1 Burnett House, Lewisham Hill, Lewisham, S.E.13.
Lyons, S. L.	105-109 Judd Street, London, W.C.1.
Murfet, A. V.	11 Springfield Road, Tottenham, N.15.
Nusum, C. G.	c/o The G.E.C. of Trinidad Ltd., P.O. Box 942, Port of Spain, Trinidad, T.W.I.
Pinnell, A. H. C.	c/o H.K. Electric Co. Ltd., "Tricity House," Ice House Street, Hong Kong.
Slaski, Z. P.	38-39 Upper Thames Street, London, E.C.4.
Venn, B. W. C.	126 Muller Road, Horfield, Bristol, 7.

Students

Butler, A. K.	4 Darfield Avenue, Harehills, Leeds, 8.
Hall, B. A.	Tudor House, Howard Road, Gt. Bookham, Nr. Leatherhead, Surrey.
Shaw, D. A.	18 The Leases, Beverley, E. Yorks.

Society Publications

For more than twenty years the Transactions of the Society have recorded the many and varied contributions of members towards the advancement of the art and science of lighting, and today the Transactions comprise a technical literature of which the Society may justly be proud.

With the developing work of the Society and the widening interests of its members, Council decided that the publication policy should be reviewed, having in mind particularly the considerable amount of highly specialised research now in progress and also the practical outcome of the activities of the Technical Committee.

These discussions have led to the development of a publication policy that should result in better service to members and further enhance the international prestige of the Society.

It had been suggested from time to time that some of the highly specialised contributions to the Transactions, while of great importance to a small number of experts, had limited interest for the majority of members. On the other hand, it had to be recognised that this advanced work was vital to the progress of lighting technology and to the scientific reputation of the Society.

Council has decided to meet these partially conflicting requirements by instituting a monograph service. Written contributions which are judged worthy of publication but by reason of their subject matter are considered too specialised for most readers will be issued as Society Monographs at a price of five shillings. Contributions of more general interest—but of not less quality—will be published as before in the Transactions as will papers presented at meetings in London. By this means members will be able to add to the technical contents of the Transactions those particular specialised papers in which they are interested. By the same means the Society will be able to invite more freely these advanced contributions which in time will constitute a literature unique in the lighting world. Contributions published in the Monographs will be eligible with those published in the Transactions for the Leon Gaster Memorial Premium.

A third type of publication to be made available in the immediate future is what are to be known as I.E.S. Technical Reports. These Reports are being produced by panels of the Technical Committee charged with studying selected aspects of lighting practice, and are designed to provide authoritative guidance to the practising engineer, architect and contractor. I.E.S. Technical Reports, which will also be issued at five shillings, may be regarded as supplementing the I.E.S. Code and should prove of great value to all concerned with lighting practice.

Both Monographs and Technical Reports will have the same format as the new Transactions and as they become ready for issue, details will be announced in the Transactions. Copies will be obtainable from The Secretary, The Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

It is particularly happy and appropriate that this more extensive publication policy offering an improved service to members can be announced as the Society enters on its Jubilee year.

I.E.S. Technical Report No. 1

Lighting in Corrosive, Flammable and Explosive Situations

This Report deals with the installation of lighting equipment in situations made hazardous by the presence of sources of fire and explosion or by the presence of corrosive liquids and gases. Prepared in consultation with the National Illumination Committee of Great Britain, this Report is an authoritative introduction and guide to present British practice in this complicated subject. Copies (price 5s. each, by post, 5/6d.) may be obtained from The Secretary, I.E.S., 32 Victoria Street, London, S.W.1.

Printed in England by
Knapp, Drewett & Sons Ltd., 30 Victoria Street, London, SW1
and published by
THE ILLUMINATING ENGINEERING SOCIETY
32 Victoria Street, London, SW1

Annual Subscription to Non-Members — £2.2.0
Price per number to Non-Members — 10s 6d